Short-Wave Handbook

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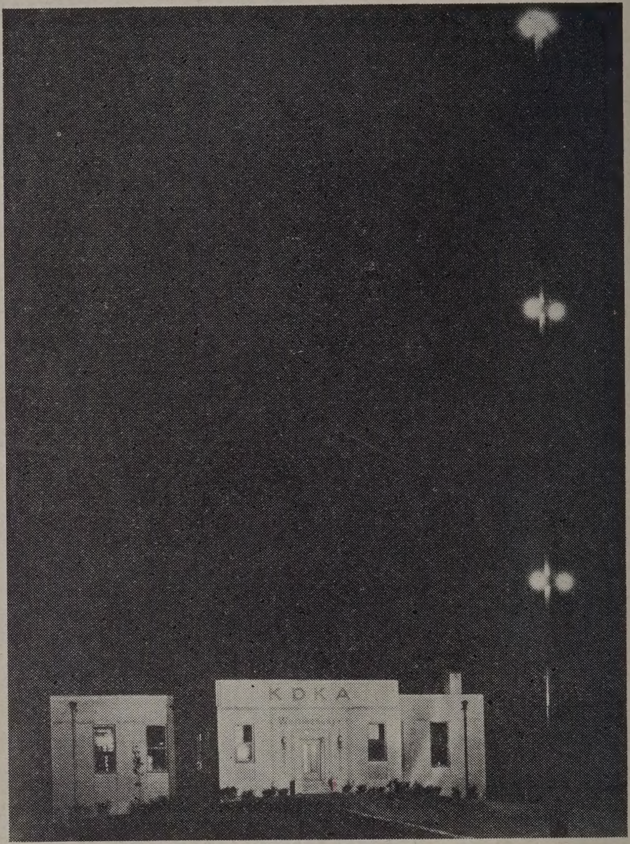

A PIONEER SHORT-WAVE STATION

A night picture of a famous short-wave international transmitter, Westinghouse stations KDKA and W8XK showing the antenna mast which is luminescent with high-power discharge.

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INTRODUCTION

All the old-time thrill of listening to distant broadcast stations—and a lot more—now awaits the short-wave radio enthusiast. Short waves have opened up the vistas of DX a hundred fold and with a good short-wave receiver it is now possible to tune in stations situated anywhere on the globe and to get reception of news and novel broadcasts, as well as hearing directly the world's great men just as if they were talking into a local broadcasting microphone. But there are so many things to be learned by the listener about the short waves before he can really be classed as an experienced short-wave DX'er that many who are naturally drawn to this wholesome hobby lose interest because they do not immediately get results.

The whole purpose of this book is to present to the short-wave fan, in understandable style, the principles underlying short-wave work. The material presented contains all the information necessary to get good reception, how to tune and when and where to listen, as well as how to build short-wave equipment. It has been compiled and edited from the works of more than one hundred well-known experts in this field. The Editors feel that it will be found a worth-while addition to the short-wave fan's usually meager supply of information.

Lawrence M. Cockaday

CHAPTER 1

Fundamental Principles Underlying Short-Wave Communication

NOW that short-wave broadcast stations are rapidly springing up all over the world and many of the largest manufacturers of radio receivers are putting on the market complete sets or adapters and converters for use in conjunction with standard receivers that can be satisfactorily operated by the average listener, the desire to "tune in on the world" has gripped the imagination of the radio public and is no longer confined only to those having a knowledge of the fundamentals of radio design.

In many cases listeners have been led to believe that tuning in the short waves is merely a matter of twirling the dials and stations from every part of the globe come rolling in with local reception. Certain natural phenomena govern short-wave transmissions and subject them to various peculiarities. Distant stations that are heard during the day should not as a general rule be expected to be heard on the same frequency after darkness falls, those that are heard in the summer in many instances are not heard in the winter, and so on.

Listeners accustomed to DXing only on the regular broadcast band expect the best results after midnight. However, this is not necessarily the case on the short-wave spectrum and there is little possibility of DX under the present operating schedules of the distant stations for American listeners between the hours of midnight and about 5:00 a.m., as compared with the possibilities during the day and evening hours.

Various suggestions relating to the hours best suited for tuning on specified frequencies are offered from time to time. The theory has been advanced that best reception is obtained from distant stations operating on frequencies between 21,400 kc. and 15,800 kc. (13 to 19 m.) when daylight prevails at the receiving location, from those operating between 15,800 and 8570 kc. (19 to 35 m.) when dark at the transmitting location and light at the receiving location, and from those operating below 8570 kc. (above 35 m.) when total darkness prevails between transmitter and receiver. While this schedule holds true to some extent, definite conclusions cannot always be anticipated in actual practice.

Contrary to the generally accepted theory that stations transmitting on frequencies of 6250 to 6000 kc. (48 to 50 m.) are heard best while darkness prevails, particularly at the receiving end, Australians and New Zealanders hear American 48-50 m. stations in the morning and afternoon and report best signal strength at about 4:00 p.m., their time.

It is quite evident that the location of the transmitter with respect to that of the receiver governs to a great extent what frequencies should be satisfactory for daylight reception and those that should be satisfactory for reception after dark.

FIGURE 1

WORLD DISTANCE CHART

The distorted map shown here permits direct measurement of the mileage between New York and any point in the world. To use the map, take a ruler and find the distance in inches between New York and the desired point, multiply by the miles per inch shown on the scale and the answer will be the approximate airline distance between the two points. Distances from points other than New York can in many cases be closely approximated by reference to New York. To determine the distance between San Francisco and Melbourne, Australia, for instance, the distance from Melbourne to New York is found and from this is subtracted the distance from San Francisco to New York.

So that those uninitiated to short-wave radio reception may more fully comprehend the various peculiarities and "exceptions to the rule" to contend with, it might be well to record here a few observations made in Chicago.

One morning in July, 1930, at about 7:00 a.m., a station in Australia was heard calling one in California. The Californian could not receive the transmissions from Australia, so communication was established through a station in New York, which relayed the signal to California. As time progressed the signal from Australia diminished in strength in Chicago and New York, but became audible in California, so that contact was made direct. Gradually the signal faded out completely in the Eastern States but steadily improved in the Western States. This is a typical example of what takes place in short-wave radio transmission and is the result of "skip-distance," the wave passing over one location, refracted by the Kennelly-Heaviside layer and received in a more remote location.

The phenomenon displayed by short waves in overcoming the curvature of the earth's surface was hypothetically explained by Kennelly and Heaviside, American and English scientists, as the result of a refracting or reflecting effect, and the existence of such a refractive medium having been definitely established, it became known as the Kennelly-Heaviside layer, more generally referred to as the Heaviside layer. It is imagined as an ionized region varying in height from fifty to five hundred miles above the earth's surface, and should not be thought of as a well-defined reflector but rather as a refracting medium, since radio waves, which differ from light waves only in length, are caused to be bent or refracted upon entering at an oblique angle a region of less electron density rather than deflected as though by a reflecting surface.

In short-wave transmission two waves are propagated, a ground wave that on the higher frequencies travels from thirty to fifty miles and a sky wave which travels skyward at an inclination and is refracted by the Heaviside layer, resulting in a skip-distance, which is the distance from the transmitter or the limit of the ground wave to the point where the refracted ray first returns to the earth. At a fixed layer height, skip-distance increases as the wavelength decreases and for a given wavelength the skip-distance increases as the layer rises. Since the earth's surface, particularly if wet, possesses reflective qualities, a radio wave after being refracted by the Heaviside layer may be reflected obliquely up again and again refracted.

Another typical example of skip-distance effect as observed from Chicago is to be found on the 12,000 kc. (25 m.) band. At certain hours W8XK in Pittsburgh, Pennsylvania, only 450 miles distant, is hardly audible or is not heard at all, while GSB in England, I2RO in Italy and the French Colonial station at Pontoise may at the same hour be heard with perfect clarity and much volume.

In the City of Buenos Aires there is in operation a device for the transmission of radio telegraphy and telephony which resembles a huge plane parabolic reflector approximately twenty feet long and eight feet high. It is built of wood and covered inside with metal foil. In the focus of this reflector there is a bi-pole antenna. The interesting thing is that this reflector points *toward the sky*, its axis at an angle of approximately 22½° with the horizontal level of the

surface of the earth, as though its rays should shoot upward into the atmosphere for communication with some unknown being on another planet. Curiously, however, this unknown being speaks with a strongly German accent. As a matter of fact, the correlating station which is addressed by this reflector in the South American city, is not outside of the globe of our Mother Earth at all, but is near Berlin —in Koenigswusterhausen, and the physical fact which made possible this unusual way of communication between these two points is perhaps the one which is the most important today for general long-distance communication between two points, namely, the existence of a reflecting layer in the upper atmosphere, called after its investigators, the Kennelly-Heaviside layer.

If there exists any preference between the various planets of our solar system, from a radio standpoint it is that the layers which surround the earth seem to be the only ones from which short waves can rebound and thus make it possible to reach receiving stations many thousands of miles distant from the short-wave transmitting station.

It is probable that on no other planet of our solar system would radio communication on short waves be possible, because such layers cannot be built up there, due to the lack of our typical atmosphere. We humans of the 20th century should consider ourselves rather fortunate that we are living upon an earth that is surrounded by this type of atmosphere. We radio short-wave fans should be thankful because it is this fact that brings about the reception of signals from around the world.

How does this transmission take place? Long after Hertz and later Marconi made their fundamental experiments, it was stated (and proven theoretically) that a communication from point to point could be made only with radio waves of considerable wavelength which followed the curvature of the ground without being absorbed too much. In the early days of radio transmission, particularly in over-seas services, it was the usual thing to apply wavelengths up to several miles. Tremendous power was necessary at such wavelengths and the development of radio-transmitting apparatus, at that time, centered around the point of increasing the energy of the transmitting machines and enlarging the height and length of the antenna, the signal intensity at the distant point being, among other things, directly proportionate to the power of the transmitter and the height of the antenna.

At that time only negligible power could be produced on the short wavelengths, which, moreover, were found to be more strongly absorbed in the ground, and thus they were considered to be out of the question for reliable communication purposes. Therefore these short waves were "given" to the amateur to work with, and we have to thank the persistency and ability of these early amateurs for the present developments of long-distance communication with greatly simplified means, both in constructional details worked out and in expenditures. Experimentation of this sort has finally made possible a service to humanity which seemed ridiculous to the early theorists. It proves again that we must *not put too much confidence in theories alone!* Theory, after all, can express only as much as the actual facts entering into it. And sometimes there are many facts missing. But

let us confess humbly that our knowledge of facts in this vast unexplored region of natural phenomena is small. It is only within the last decades of our thousands of years of civilization that we have begun to investigate nature systematically.

The fact which was not included in the early electromagnetic theories about the phenomena of radio transmission was that any other possibilities for radio transmission—outside of a wave traveling along the ground—was neglected.

Similar to the neon in advertising signs which illuminate Broadway at night, the gases of the upper atmosphere, at reduced pressure, become conductors of electricity. If they are bombarded by electrons streaming out from the sun, we have the heavenly luminous discharge tubes called the Aurora Borealis. And, as they are conductors of electricity, they are, like other conductors, able to reflect radio waves

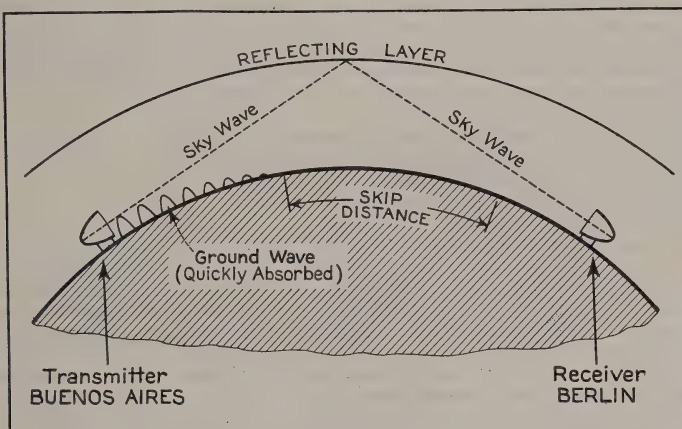


FIGURE 2

of certain wavelengths. Of course, they are not quite as good conductors of electricity as, for instance, copper or silver, and so this reflection is not a perfect one, but more of the type of a gradual refraction.

The layers of the atmosphere surrounding our earth are not homogeneous, but are considered to consist of layers of various dielectric properties and different electrical conductivity, both of which factors have a definite relation to the specific propogation of electromagnetic waves of various wavelengths.

In 1900 Lenard had already shown that ultra-violet light is able to ionize gases of various types by its direct influence upon its smallest composing parts.[1] He had shown that such light can split up atoms. Moreover, the phenomena of the Aurora Borealis, of the Northern Lights and other facts of atmospheric phenomena, have proven that there are regions in the upper atmosphere where irregularities occur. It was as early as 1882 that Stewart considered the daily variation of

the earth's magnetic field as a proof of the existence of a conducting layer in the upper atmosphere. The existence of the Heaviside layer is now daily proved in several countries and its heights and the density of its charge is regularly measured. In addition, this information about the state of the upper atmosphere, regions where no sounding balloon can penetrate, may some day become useful in forecasting the weather. Considerable material on this subject was collected by Harlan T. Stetson, whose chief interest was primarily astronomy. As far as one hundred years ago this idea was also conceived by the British economist Jevons. A book was written on the subject by Ellsworth Huntington. It's title is "Earth and Sun." And it was Sir William Beveridge who made forecasts of wheat prices, based upon similar considerations. The series of experiments made between the transmitter of the Naval Research Laboratory and the receiver in the Department of Terrestrial Magnetism in Washington, D. C., were important. During the period from December 19, 1927, to January 16, 1928, signals of very short duration were investigated by G. Breit, M. A. Tuve and O. Dahl.[2]

While the extremely short waves, like light, for example, can penetrate these gaseous layers, they act as a reflector similar to metal for somewhat larger waves.

This layer of varying electric behavior is produced, according to the present state of our knowledge, by three actions:

(A) Electronic bombardment
(B) Ultra-violet light and
(C) Cosmic rays.

The last influence—cosmic rays—is of the most penetrating, hardest type, being quantitatively absorbed only to a very small extent and therefore producing little ionization. However, while this total reaction is a small one, its quantitative distribution may become of importance in investigations pertaining to the upper layers of the stratosphere. There is reason to believe that the application of such investigations may become of value in later years when stratospheric aeronautics may have passed the stage of experimentation and become a reality of daily life.

As to ultra-violet light and electronic bombardment, these phenomena have a relation to the action of the sun for creating the ionized layers. Both ultra-violet light and electronic bombardment are believed to be important in creating the layers. At the present time, the effect of ultra-violet light seems to be in the foreground. Particularly during the last eclipse, measurements have been made by various investigators which seem to prove that the influences of the electronic eclipse upon the reflecting layer are small in comparison with the optical eclipse. A final conclusion has not been reached as to which of these two theories is of greatest importance. It is interestinging to note, however, that there is a connection between the variations in the earth's magnetic field, sun spots, the emission of electrons from the sun, and the intensity of radio signals. It seems that the electronic disturbances which bring about changes in terrestrial magnetism and produce the heavenly displays of the Aurora are able also to markedly influence the Kennelly-Heaviside layer. An *outburst of solar activity,* such as takes place by an increase of sun spots, *"lowers" the Kennelly-Heaviside* layer. Heavier ionization of the outer layers

of the atmosphere occurs and the total Kennelly-Heaviside layer is said to move toward the surface of the earth.

Changes in solar activity, as demonstrated by sun spots, have a relation to changes of the earth's magnetic characteristics, both in regard to their intensity and direction.

Amplitude and duration of disturbance in short waves, as shown in the field intensity at the receiving points, are considerably greater between points where the communication passes near the earth's magnetic poles than, for instance, the communication line between New York and Berlin. Such lines which have a communication parallel to or in the neighborhood of the equator, as, for instance, Berlin to Cairo, have been proved to be less affected by such disturbances. Considerable statistical material on this effect has been published by H. Mogel.[3]

The correlation between radio intensity and sun spot numbers is shown graphically in Figures 3 and 4.

It is perhaps more than an accident that, just now, interest in long-distance reception is increasing so rapidly. It is not only that the highly perfected radio sciences, the new tubes and circuits, have made possible the construction of apparatus which does give efficient

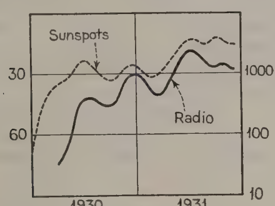


FIGURE 3

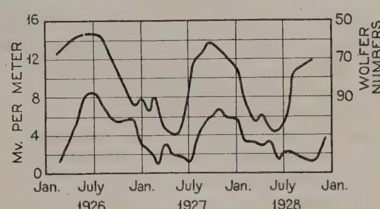


FIGURE 4

short-wave world reception, but, in addition, that we are approaching a *period where sun spot activity tends toward a minimum and therefore long-distance reception is getting better and better.* This condition will last another few years. Thereafter, the sun spot activity will increase again and it may be predicted with reasonable certainty that the long-distance reception will then slowly suffer.

Figure 2 shows schematically how a signal travels, according to the older theories which assume only one perfectly reflecting gaseous layer. After a considerable distance the *skip distance*, the signals fade out. Farther on, they come in again. It becomes clear that such waves have not been transmitted along the ground; they must have been reflected from somewhere up in the sky.

Figure 5 shows schematically how fading is produced. The transmitter, T, emits waves which travel either over the path, TBCD, to the receiver, R, being reflected once from the ground and twice from a conducting layer in the atmosphere. The other path goes through the point E, having one reflection only. Naturally, there is a difference in the length of these paths and the two incoming waves may interfere with each other, like light waves interfere with each other if they are reflected from a grating. So, by using directional antenna systems, the signal intensity in a certain direction is in-

creased, and, in addition, fading can be greatly reduced. Short-wave transmitting stations of the type used for telephone communication between the United States and Europe or South America are of the double net type. For the transmission to Europe, for instance, the short-wave aerial of the American Telephone and Telegraph Company at Lawrenceville, New Jersey (near Trenton), consists of a double net supported on twenty-one towers in a row, laid out at right angles to a line extending from Lawrenceville to the short-wave receiving station near London. Similarly, the transmitting towers, which are one hundred and eighty feet high and two hundred and fifty feet apart, are set in right angles to the direction of Buenos Aires for communicating with this city. And for still shorter waves, plane-parabolic and circular-parabolic reflectors may be used.

By the use of directional antenna systems in both transmitter and receiver and the use of automatic volume control and diversity systems, the effect of fading can be almost eliminated.

While only one continuous reflecting layer had originally been assumed, this hypothesis soon did not explain the various facts disclosed in systematic investigations. There is one phenomenon which, particularly, cannot be explained directly by the fact described above and which perhaps is the most interesting of them all. The Norwegian radio amateur, Jörgen Hals, has observed that echoes of short-wave signals could be noted, which were several seconds removed from the original signal. He told these observations to Professor Carl Stoermer. The latter, together with Dr. Balth van der Pol of the Natuurkundig Laboratorium der N. V. Philips, Holland, made a series of experiments and arranged special transmission with the Philips short-wave transmitter PCJ for the study of these phenomena. Interesting echoes have also been observed by A. Hoyt Taylor and L. C. Young.[4]

It was found that several echoes were received at the same moment, in Norway by Dr. van der Pol, and independently by his assistant with a different receiver, in Eindhoven.

The time observed between the signals and the echoes was: 8, 11, 15, 8, 13, 3, 8, 8, 8, 12, 15, 13, 8, 8 seconds.[5] Considering the fact that electromagnetic waves travel 186,284 miles per second, it seemed at the first impression that these waves must have traveled distances many times greater than the diameter or the circumference of the earth—distances which are in the dimension of the distance between the moon and the earth, and possibly even further than that.

The frequency of the echo was always exactly equal to the frequency of the signal. They could be readily identified. Combination tones received always had the same pitch (though of course of smaller intensity) regardless of whether the original signal was received or the echo.

As an explanation, Professor Stoermer tries to explain this phenomenon in that these waves are supposed to penetrate through the Kennelly-Heaviside layer, traveling into space distances several times the distance between the earth and the moon.

Figure 6 shows a sketched interpretation of the original Stoermer hypothesis. These waves are supposed to be reflected by hypothetic clouds of electrons which travel in these regions. The electron clouds are believed to have been emitted from the sun.

Contrary to this explanation, Dr. van der Pol has published a different theory. He assumes that these waves, under certain conditions, have been considerably delayed. According to his theory, they travel over a certain distance *within the Heaviside layer!* This is in the conductive layer above the ground which varies between 60 and 150 miles in height above the ground. He has shown mathematically that at places where the ionization is critical, the velocity of the propagation becomes infinite, but at the same time *the group velocity moves toward the zero limit.*

Under certain conditions the waves may enter the layer and travel within this layer into regions where the group velocity is small. In regions where the dielectric constant falls to a low value, they again may be reflected toward the earth. Although such waves may *never*

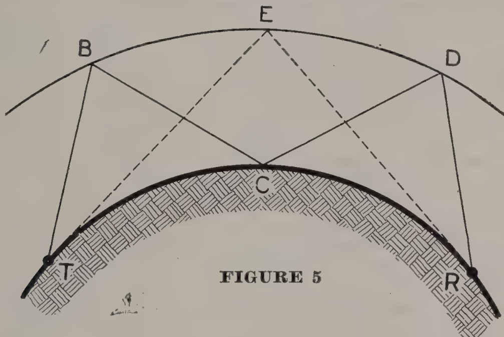


FIGURE 5

have traveled outside the earth atmosphere, a considerable time may elapse before the echo is received.

The present scientific world tends more and more toward the opinion that the theories similar to the one of Dr. van der Pol are the best interpretation of this phenomena.[6]

Figure 7 shows schematically what is believed to be the working hypothesis with the greatest approximation to the truth. The sky wave, according to this theory, does not bounce back immediately from one and only one reflecting layer, as was originally assumed. There may be a number of layers with different dielectric characteristics and an actual refraction and under certain circumstances even a considerable wave retardation may occur by reflecting radio signals in between the borders of these layers. One of these layers is called the Appleton layer. Naturally, as the earth is a sphere, and, accordingly, those layers have to be three-dimensional, echoes may be transmitted from various parts of the globe; hence the difference in time, intensity, polarization and other characteristics. The fact of the earth's magnetism enters here also. This also may explain the difference in the best wavelength for communication over distances which are at least partially irradiated by the sun and the different wavelengths most suitable for communication at night in their daily and yearly variations. For even shorter wavelengths in the ultra-short-wave region, as used for the transmission of television signals, still additional factors enter. While the longer ones of these waves are still, partly

at least, reflected by the gaseous layers, the fact occurs, irritating for reception, that the field intensity at points a few feet apart from each other may be considerably different. For instance, in the center of a room there may be good reception while near a wall no signal can be received. The differences in these field intensities, however, is not due to any influences of the higher atmosphere, but is merely due to interference waves created by objects in the neighborhood of the transmitter and the receiver.

Perfectly free from reflection on the outer layers of the atmosphere are only the shortest centimeter waves of 20 centimeter wavelength and less. While at the longer waves of about 50 centimeters wavelength, as used in the experiments of Marconi, some reflection occurs, waves of the range of 20 centimeters or less pass through the Kennelly-Heaviside layer practically unabsorbed.

Marconi's newest reflector for his 50-centimeter wave system is now in operation on the Vatican. Contrary to previous belief that these waves are not intercepted below the curvature of the earth, he has made occasional receptions at distances of about 80 miles and more. This, however, was no permanent and reliably reproduceable effect. His transmitter was pointed at clouds in the sky and the scattered radiation obtained from them was used for reception purposes, similar to the way a searchlight beyond the horizon can be seen far above its regular range, if it illuminates clouds far up in the sky.

In experiments at 15 centimeters wavelength and less, no transmitter signals were noted at considerable distances below the horizon. These "micro" waves, similar to light waves, are able to pass through the layers and are not reflected to any practical extent. Still, there seems to be an influence of the sun upon the transmission. If the sun was shining upon the reflectors, changes in the signal intensity and in the random noise occurred. Is it possible that the sun sends out not only light waves, but also such parts of the electromagnetic spectrum as are in the dimension of micro waves?

The effects of skip-distance are equally applicable to other frequencies, and it is not uncommon to hear DJA, Zeesen, Germany, on 9560 kc. (31.38 m.) at an hour when W1XAZ in Springfield, Massachusetts, on 9570 kc. (31.36 m.), or W2XAF in Schenectady, New York, on 9530 kc. (31.48 m.), are barely audible. When local stations transmitting on the 6250-6120 kc. (48-49 m.) band are of poor volume and reception of them ruined by rapid fading, stations on practically the same frequencies located in South America may be coming through with excellent clarity and volume.

Listeners in Wellington, New Zealand, report poor reception of the broadcasts from VK2ME in Sydney, Australia, at an hour when Chicagoans are enjoying the best possible reception of the same program, the signal reaching New Zealand being distorted and "shaky" as the result of skip-distance and rapid fading.

Innumerable cases could be quoted wherein listeners in America have intercepted with perfect results programs radiated by stations in Europe, Central and South America, Hawaii and other countries and intended for reception by receiving stations on the Atlantic and Pacific coasts of the United States for rebroadcast purposes, but which, due to skip-distance effects, were prevented being relayed or which were received poorly.

As has already been explained, the skip-distance effect depends upon the height of the ionized layer of air known as the Heaviside layer, and as the height varies, the signal strength varies. A great change may take place in an amazingly short period of time, as may be realized by a somewhat unusual example. One listener called another by telephone for the purpose of passing on the information that EAQ in Spain was transmitting a musical program for American listeners on 9870 kc. (30.4 m.) and coming in with tremendous volume. The listener called lost no time in tuning for the station, but it was only with difficulty that he located it, though the exact spot on the dial for that frequency was known. He later expressed surprise that they should have experienced such unlike results, but it developed that the first listener also had difficulty in again locating the station after returning to his set, so weak had the signal strength become during the few minutes intermission at the telephone.

The Heaviside layer may vary slowly in height and cause a slow disappearing and reappearing of the signal or may vary rapidly and cause an exceedingly rapid fluctuation in signal strength so as to make the program items unintelligible. This latter condition is known as "rapid fading" or "fluttering" and is generally noticed or is more pronounced before or after the signal is at its peak in the locality of interception. This phenomenon may be experienced whether the station be only a few miles distant or thousands of miles distant.

The fascinating pastime of tuning in foreign stations has attracted men and women of all ages from every walk of life. It has been said that "Distance lends enchantment, except when you're out of gas." The motorist and the aviator must prepare for such emergencies but the short-wave enthusiast can travel, without a care, to many countries of the world over the shortest possible distances in fractions of a second, hear the native music of far-off Java, Indo-China and Japan, listen to the delightful Spanish language of Central and South America, the English accents of Great Britain and Australia and other interesting features peculiar to countries whose customs, language and music are vastly different than our own. Romance, via the high frequencies, exists for the owner of a short-wave radio receiver, regardless of sex, nationality, position or age!

The effects of sunrise and sunset on s.w. transmission presents an interesting study. Conclusions based on observations of stations

FIGURE 6

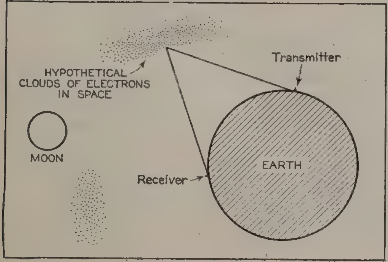
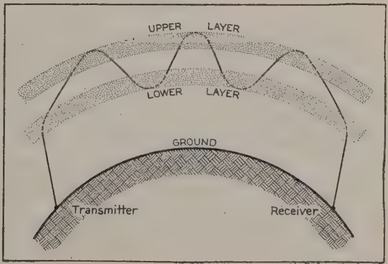


FIGURE 7



VK2ME and VK3ME in Australia operating on approximately 9590 kc. (31.28 m.) are that maximum results are obtained in Chicago from shortly before sunrise until one or two hours after sunrise, regardless of the time of year.

Undoubtedly short-wave radio reception is affected by atmospheric conditions but it does not necessarily follow that stormy or unsettled weather is unfavorable for good results from distant stations. Very frequently transmissions from Australia, Europe and South America are intercepted in Canada and the United States during the height of a thunder and lightning storm with excellent volume and audibility, impaired only by the direct interference caused by the individual flashes of lightning. According to repeated observations, wet weather appears to improve reception considerably in many cases. This is probably especially true where the storm is more or less localized, as when unsettled weather conditions extend over a vast area distant reception generally is partially impaired or totally ruined.

Although it is generally understood that short waves are more dependable for long distance communication than long waves, it should not be concluded that short waves can be intercepted with 100 percent consistency. The English and American stations engaged in commercial telephony for trans-Atlantic traffic, as well as the ship-to-shore stations, can not rely upon any one frequency for any certain hours with absolute dependability. In many instances, especially when an international broadcast is in progress, two or more short-wave stations operating on entirely different frequencies are used in parallel to insure the best possible reception. If the short waves fail to hold up, long-wave transmitters operating on 60 kc. (5000 m.) with as much as 1000 kilowatts power are used.

The power used by a short-wave station does not govern whether or not it will be heard in some remote locality. Unlimited power and the most efficient receiver will not necessarily result in a signal being intercepted.

Possibly the nature of the earth's surface over which the signal passes affects the strength of the signal to some extent, since transmission over water is generally more satisfactory than transmission over land due, in part, to the reflecting characteristics of water. Vast forests, such as those of Siberia, have a tendency to absorb radio transmissions. This absorption is considerably less on the higher frequencies.

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[2] G. Breit, and M. A. Tuve: A text of the existence of the conducting layer. Phys. Rev. 28, 1926, 554.

G. Breit, M. Tuve and O. Dahl: Effective height of the Kennelly-Heaviside layer. Proc. Inst. Rad. Eng. 16, 1928, 1236.

[3] H Mogel. Telefunken Zeitg, 11, Nr. 56 (1930), 14.

[4] A. Hoyt Taylor and L. C. Young—Proc. Inst. Radio Eng., 16, 561; 1928.

[5] Balth, der van der Pol—Nature, December 8, 1928.

[6] P. O. Pedersen, Wireless echoes of long delay, Proc. Inst. Rad. Eng. 17, 1929, 1750.

CHAPTER 2

Helpful Short-Wave Data

REALIZING that their programmes are reaching the ears of thousands in many lands who might not be familiar with the language of the country where the transmission originates, short-wave stations in a great many cases adopt a signal that establishes beyond peradventure the identity of their station. As an aid in identifying station call letters, the alphabet and first ten or twelve numerals of some of the more important languages, such as Spanish, French and German, should be memorized. Since many of the commercial and experimental stations sign off with the International Morse Code, it is to a listener's advantage to be familiar with that code.

Most stations welcome reports of reception from their listeners, especially the experimental stations transmitting musical programs. Many listeners are equally interested in receiving confirmations of their reception from the various stations. A request for such verification should include date of reception; frequency of wave length; details of program items with the actual time of musical selections, songs, announcements, etc., given in local time, time at place of origin of transmission or, preferably, Greenwich Mean Time (G.M.T.). Volume or audibility expressed in the R system and readibility expressed in the QSA system; quality of modulation; kind of receiver; temperature; barometric pressure; whether rising or falling barometer and general weather conditions; conditions of ground; official hour of sunrise or sunset if reception is effected just before or after these times are other details of interest which may be included. An International Postal Reply Coupon is necessary in most cases, if a reply is desired. Stations do not all require a complete log of reception or the actual identification of even a single selection, since in many cases either no transmission log is maintained or no reference is made to the log when verifying a report. Other stations are very particular on this point, however. Nor is it necessary to comply with the other conditions suggested, although the order given here constitutes a good report and is of value to the station owner.

The commercial stations as a rule do not verify telephonic transmission not intended for general public reception, since such communication is classified by international treaty as correspondence of a private nature of which the unauthorized reception by any chance intercepting listener is in violation of the secrecy provisions of the International Radio Convention.

In such instances where the highest possible degree of secrecy is desired or must be exercised a special device known as a "demodulator" is employed which causes the speech and music to become "scrambled," the high notes being turned into low ones and the low notes into high ones, making the voice unintelligible. Special receiving apparatus is required to "unscramble" this "inverted modulation," the inverted notes resuming their original positions. No wonder that when listeners hear this strange jargon they are convinced that they are receiving emissions from Chinese stations or else begin dismantling their receivers to locate the cause of the distortion!

Longitude		Zone	TODAY (HOY)													TOMORROW (MAÑANA)											Zona	Longitud	
EAST	180	1	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	1	ESTE	180
"	165	2	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	2	"	165
"	150	3	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	3	"	150
"	135	4	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	4	"	135
"	120	5	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	5	"	120
"	105	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	6	"	105
"	90	7	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	7	"	90
"	75	8	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	8	"	75
"	60	9	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	9	"	60
"	45	10	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	10	"	45
"	30	11	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	11	"	30
"	15	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	12	"	15
	0	13	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	13		0
WEST	15	14	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	14	OESTE	15
"	30	15	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	15	"	30
"	45	16	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	16	"	45
"	60	17	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	17	"	60
"	75	18	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	18	"	75
"	90	19	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	19	"	90
"	105	20	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	20	"	105
"	120	21	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	21	"	120
"	135	22	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	22	"	135
"	150	23	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	23	"	150
"	165	24	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	24	"	165
			YESTERDAY (AYER)																										

FIGURE 8

RADIO TIME CHART OF THE WORLD

This chart will enable you to tell at a glance the time in any country of the world, corresponding to any hour of the day, local time. By the use of this conversion chart, short-wave reception of foreign stations is greatly simplified and better results in DXing will be obtainable. Read the simple instructions given in the following pages describing the use of this time chart.

One of the most interesting considerations in connection with the interception of foreign short-wave radio emissions is the difference in time between the respective locations of transmitter and receiver. As "the iron tongue of midnight hath toll'd twelve" and the final stroke of famous Big Ben is being broadcast to the world over GSB, ushering in a new day, Chicagoans will have heard it 6 hours earlier, the day before it was broadcast, while Australians will have tuned it in just after 10 o'clock in the morning of the same day.

Distance alone does not govern difference in time. There is a difference in time between New York and Sydney, Australia, a distance of over 10,000 miles, of 15 hours; and between New York and Wellington, New Zealand, a distance of less than 9,000 miles, of 16½ hours. At 9:00 a.m. in Chicago it is 1:00 a.m. in Sydney the next day, a difference of 16 hours. Though Los Angeles, California, is 1,170 miles closer to Sydney than is Chicago, yet the difference in time is 18 hours; Honolulu, Hawaii, is over 4,000 miles closer but there is a difference of 20½ hours. A less difference in mileage may result in a much greater difference in time. Samoa is separated from Suva, Fiji Islands, by only about 700 miles but by 23½ hours, Samoa being on one side of the International Date Line and Suva on the other.

The International Date Line, also known as the Admiralty Date Line or Shippers' Date Line, is an arbitrary line curving east and west of the 180th Meridian in such a manner as to lie always in the ocean. This is the official starting point of every day, every year, every century. From here day speeds Westward at about a thousand miles an hour along the Equator. Day first dawns on the Chatham Isles with its population of a couple of hundred shepherds and fishermen, about 400 miles southeast of Wellington, New Zealand.

USE OF THE TIME-CONVERSION CHART

The time-conversion chart shown in Figure 8 makes it a simple matter to find the time in any country of the world, corresponding to any hour of the day, local time.

For convenience, the world has been divided into 24 zones, each running from North Pole to South Pole and 15 degrees of longitude wide. Each zone differs one whole hour in time from the next. In using the chart, the first thing to do is to find out in what zone you live by referring to the list that follows. It is suggested that you draw horizontal lines across the chart immediately above and below this zone.

Running along the line of your zone, find the numeral representing the local time. Then in the vertical column in which that hour appears you find the corresponding hour for any other zone.

Example: Suppose you live in New York and it is 5 p.m. You wish to know what time it is in Japan. Looking in the list of countries, you find U. S. A. Eastern Standard Time falls in Zone 18. Japan is found to be in Zone 4. Now refer to the conversion chart. On the line beginning with West 75 degrees, Zone 18, find the heavy figure 5, meaning 5 p.m. Then following up this column until you reach the line of Zone 4, you find a light figure 7, which means it is 7 a.m. in Japan. The triangle of figures in that upper right-hand corner is marked "tomorrow." Therefore it is 7 a.m. tomorrow morning in

Japan. It is obvious that someone in New York always starts out with the line of Zone 18, hence the reason for marking it.

Another example: Someone living in Rome wishes to know what time it is in Vancouver, B. C., when it is noon, Rome Time. The list of countries shows Italy to be in Zone 12 (this zone has central European Time). British Columbia is listed under Canada and is in Zone 21 (Pacific Standard Time). In the chart, refer to the line of Zone 12 and the figure 12 noon. Going downwards to the line of Zone 21, you find 3 a.m. in the morning of the same day as the time in Vancouver. Some countries have a standard time which differs from the time of a standard zone by an odd number of minutes.

TIME ZONES

Alaska	
Ketchikan	21
Cordova	22
Sitka	22
Southern Portion	22
Central Portion	24
Aleutian Islands	24
West Coast	24
Albania	12
Algeria	13
Angola, Africa	12
Arabia	10
Argentina	17
Auckland Island	2
Australia	
Western Australia	5
Central Australia	
Add ½ hr to Zone 4 time.	
Northern Territory	
Add ½ hr. to Zone 4 time.	
South Australia	
Add ½ hr. to Zone 4 time.	
New South Wales	3
Queensland	3
Victoria	3
Austria	12
Azores Islands	15
Bahama Islands	18
Barbados Island	17
Bechuanaland	11
Belgium	13
Bermuda Islands	17
Bessarabia	12
Bolivia	
Add 27 min. to Zone 18 time.	
Borneo	
British North Borneo	5
Dutch Borneo:	
Balik Papan	
Add 20 min. to Zone 5 time.	
Pontianak	
Add 17 min. to Zone 6 time.	
Sarawak	
Add ½ hr. to Zone 6 time.	
Brazil	
Fernando Noronha Island	15
Isle de Trinidade	15
Bahia	16
Ceara	16
Esperito Santo	16
Goyaz	16
Maranhao	16
Minas-Geraes	16
Para	16
Parana	16
Parahyba	16
Pernambuco	16
Piauhy	16
Rio de Janeiro	16
Rio Grande do Norte	16
Rio Grande do Sul	16
Santa Catherina	16
Sao Paulo	16
Amazonas	17
Matto Grosso	17
Acre Territory	18
Bulgaria	11
Burma	
Add ½ hr. to Zone 7 time.	
Cameroon, Africa	12
Canada and Newfoundland	
Labrador (coast)	
Add 29 min. to Zone 17 time.	
Newfoundland	
Add 29 min. to Zone 17 time.	
Labrador (interior)	17
New Brunswick	17
Nova Scotia	17
Quebec (east of 68° W.)	17
Ontario (east of 90° W.)	18
Quebec (west of 68° W.)	18
Manitoba	19
Northwest Territories (eastern)	19
Ontario (west of 90°)	19
Alberta	20
Northwest Territories (middle)	20
Saskatchewan	20
British Columbia	21
Northwest Territories (western)	21
Yukon	22
Canary Islands	14
Chile	18
China	
East Coast	5
Hoihau	6
Hong Kong	5
Luichow	6
Pakhoi	6
Colombia	18
Congo	12
Costa Rica	19

Cuba 18
Curacao Island
  Add 24 min. to Zone 18. time.
Czechoslovakia 12
Danzig 12
Denmark 12
Dominican Republic
  Add 20 min. to Zone 18 time.
Ecuador
  Guayaquil
    Add 41 min. to Zone 17 time.
  Quito
    Add 46 min. to Zone 17 time.
Egypt 11
El Salvador 19
England 13
Eritrea, Africa 10
Estonia 11
  Tallinn
    Add 39 min. to Zone 12 time.
Fiji Islands 1
Finland (Soumi) 11
Formosa Island (Taiwan) 5
France 13
Germany 12
Gold Coast 13
Greece 11
Greenland 16
  Scoresby Sound 15
Guam Island 3
Guatemala 19
Guiana
  British
    Add 15 min. to Zone 17 time.
  Dutch
    Add 19 min. to Zone 17 time.
  French 17
Guinea, Africa 14
Haiti, Republic of 18
Hawaiian Islands
  Add 30 min. to Zone 24 time.
Honduras 19
  British Honduras 19
Hungary 12
Iceland 14
India
    Add 30 min. to Zone 8 time.
  Calcutta
    Add 53 min. to Zone 8 time.
  Chattagong
    Add 7 min. to Zone 7 time.
  Ceylon
    Add 30 min. to Zone 8 time.
  French Establishments
    Add 30 min. to Zone 8 time.
  Portuguese Goa
    Add 30 min. to Zone 8 time.
Indo-China 6
Iraq 10
Ireland 13
Italy 12
Ivory Coast 13
Jamaica 18
Japanese Empire 4
  Korea (Chosen) 4
Java
  Add 20 min. to Zone 6 time.
Kenya
    Add 30 min. to Zone 11 time.
Latvia 11
Liberia
  Add 16 min. to Zone 14 time.
Libia 12
Lithuania 12
Luxemburg 12
Madagascar Island 10
Madeira Island 14
Malay States, Confederated 6
Malta Island 12
Mexico (except Lower California north of 28°) 19
  Lower Calif. (north of 28° N.) 21
Morocco 13
Mozambique 11
Netherlands
  Add 20 min. to Zone 13 time.
New Guinea Island
  Western Part 4
  Eastern Part 3
New Zealand
  Add 30 min. to Zone 2 time.
Nicaragua
  Add 15 min. to Zone 19 time.
Nigeria 12
Niger Territory
  Western 13
  Eastern 12
Norway 12
Nyasaland 11
Panama 18
Paraguay
  Add 23 min. to Zone 17 time.
Persia 9
Peru 18
Philippine Islands 5
Poland 12
Portugal 13
Puerto Rico 17
Rhodesia 11
Rumania 12
Samoa Islands
  Eastern (American) 24
  Western (British)
    Add 30 min. to Zone 1 time.
Sardinia Island 12
Scotland 13
Senegal, Africa 12
Siam 6
Sierra Leone, Africa 14
Somaliland, Brit., Fr. and It. 10
Southwest Africa 11
Soviet Union (U. S. S. R.)
  Khabarovsk 4
  Kharkov 11
  Kiev 11
  Leningrad 11
  Moscow 11
  Minsk 11
Spain 13
Straits Settlements 6
Sudan, Africa
  Anglo-Egyptian 11
  French:
  Eastern 13
  Western 12
Sumatra, Dutch E. Indies 6
Sweden 12
Switzerland 12
Syria 11
Tanganyika, Africa 10

Tasmania, Australia	3
Trinidad, British	17
Tripolitania, Africa	12
Tunisia	12
Turkey	11
Ubangi Shari, Africa	12
Uganda, Africa Add 30 min. to Zone 11 time.	
Union of South Africa	11
U. S. of America	
Eastern	18
Central	19
Mountain	20
Pacific	21
Uruguay Add 30 min. to Zone 17 time.	
Venezuela Add 30 min. to Zone 18 time.	
Yugoslavia	12

OTHER NECESSARY CONSIDERATIONS

Those unfamiliar with short-wave radio reception are often of the opinion that a great number of tubes incorporated in a complicated circuit utilizing expensive components is a major requisite for the interception of transmissions from distant stations. Experimenters in various localities of America have listened to Australian programs with good volume using a set employing only two tubes in a simple circuit. Of course, for greater amplification a receiver utilizing more tubes is to be recommended but it does not always follow that the most elaborate and expensive set with many stages of amplification will give the best results. Some listeners prefer a superheterodyne circuit employing about a dozen tubes while others choose a regenerative circuit, preferably with one stage of radio-frequency ahead of a regenerative detector followed by two stages of audio frequency, possibly with push-pull in the output, making only four or five tubes in all. Though the application of alternating current has eliminated battery problems and the trouble and expense involved, nevertheless some of the most critical listeners continue to recommend battery-operation for quiet and more satisfactory reception on the high frequencies. This, however, appears to be largely a matter of individual choice.

As has already been inferred, tuning for distant short-wave stations should not be fashioned after the casual tuning of local broadcast stations. Short-wave radio receivers, covering as they do a wide range of frequencies, must of necessity tune sharply. This is readily realized when one stops to consider that a standard receiver designed for reception only of the wavelengths between 200 and 550 m. used for regular broadcast purposes covers a band of only 955 kc., from 1,500 to 545 kc., whereas a short-wave receiver designed to operate from 14 to 200 m., usually with a system of plug-in coils or change-over switches utilizing different coils for different bands, must cover 19,920 kc., from 21,420 to 1,500 kc. Of course, band-spreading devices may be obtained giving greater separation on certain bands of frequencies. The amateurs almost universally adopt some means of spreading on narrow congested bands allotted them, without which reception often would be out of the question. Though 10-kilocycle separation is considered exceedingly selective on the regular broadcast channels, such separation is practically impossible on the extremely high frequencies with even the best short-wave receiver. A selective receiver is usually required to separate PCJ, Holland, on 9,585 kc. and W1XAZ on 9,570 kc., a difference of 15 kc., or DJA, Zeesen, Germany, on 9,560 kc. from either W1XAZ with a difference of 10 kc. or W2XAF on 9,530, a difference of 30 kc. On the 6,120-kc. (49-m.) band 10-kc. separation is not so difficult. It should be noted that for the 955 kc.

equivalent to the 350 m. comprising the broadcast band the average is 3.675 m. per 10 kc. and that one m. is, on the average for this range, 2.73 kc.

Compare these results with 955 kc. near 14 m. 21,420 kc. is equivalent to 14.006 m. and 20,465 kc., a difference of 955 kc., is equivalent to 14.659 m., a difference of .653 m. as compared with a difference of 350 m. for 955 kc. on the broadcast band. Though 10 kc. represents 5 m. on the band of 375 m., on the 14-m. band 10 kc. is about six one-thousands of a meter. Thus it is seen that the same results should not be expected on short-waves where a 10-kc. separation might be only four one-thousandths, or less, of a meter as on the broadcast band where 10 kc. equals anywhere from 1.3 m. to 11 m.

It is often necessary for the short-wave listener to convert kilocycles to meters or meters to kilocycles. A convenient rule to remember is that kilocycles divided into 300,000 is the equivalent in meters and meters divided into 300,000 is the equivalent in kilocycles. For example, 300,000 divided by 1,500 kc. equals 200 m. and 300,000 divided by 200 m. equals 1,500 kc. The exact figure is 299,820 but 300,000 is accurate enough for all general purposes and is much more easily remembered.

Frequencies are often stated in megacycles, a megacycle being 1,000,000 cycles or 1,000 kc. Thus 10 megacycles equalls 10,000 kc. or 30 m. A kilocycle is, of course, 1,000 cycles.

Listeners frequently come across the perplexing situation of hearing stations on short waves that are known to broadcast only on the regular band between 545 and 1,500 kc. These "phantom" short-wave stations are harmonics radiated by the broadcast stations and although they are generally considered a nuisance, especially when one undergoes the aggravating experience of listening most intently for perhaps fifteen minutes, expecting to hear a foreign tongue, misses the announcement due to static or fading, stands by for another quarter hour or more only to find out it is a harmonic of a nearby broadcast station, nevertheless they may be used to good advantage in calibrating a short wave receiver. Take for example, a station operating on 1,500 kc. (200 m.). Its second harmonic would fall on 3,000 kc. (100 m.), its third on 4,500 kc. (66.67 m.), its fourth on 6,000 kc. (50 m.), and so on. Suppose a station is heard on a roughly estimated frequency of 9,000 kc. (33 m.) and upon checking up its correct frequency is found to be 1,280 kc. (234.2 m.). The nearest harmonic to 9,090 kc. would be the seventh harmonic, equivalent to 8,960 kc. (33.48 m.).

Harmonics must be whole multiples of the original frequency. There can be no harmonic before the second which is double the frequency or one-half the wavelength, the third being triple the frequency of the fundamental or one-third the wavelength, and so on.

At the present time much of the short-wave radio broadcasting of the world is of an experimental nature. For this reason it is impossible to draw up a list of the world's short-wave stations that can be presented to the listener with any assurance that it will not be partially out of date within a short time.

CHAPTER 3

How to Make Five Simple Short-Wave Receivers

A TWO-TUBE SHORT-WAVE PORTABLE

DURING the summer the short-wave fan may wish to carry a short-wave receiver with him on automobile or camping trips and a portable receiver will come in handy. Also, a light, portable set is useful when comparing locations for short-wave reception.

For simplicity, quietness in operation and portability, the two-volt series of tubes are the most logical to employ. A regenerative detector and single audio stage take up little room while requiring only small batteries. The entire outfit shown in Figure 9 can be put in a carrying case of approximately 12¼ inches by 8¾ inches by 6 inches, inside dimensions. With a little ingenuity, the reader will find room to place the plug-in coils, the tubes and the 'phones in the cover of the case.

The regenerative detector has always been the standby of the radio operator—both commercial and amateur. When properly operated it will give excellent results. By adding a single stage of

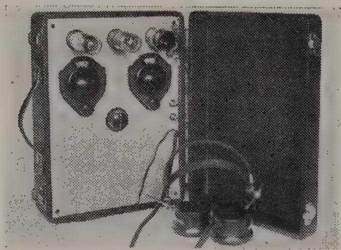


FIGURE 9

To the left is shown the two-tube portable with the cover open showing the positions of the tubes and tuning dials.

audio-frequency amplification, weak stations can be brought in more readily. Therefore, the receiver illustrated here consists of a regenerative detector and one audio stage. See Figure 10.

A capacity-coupled antenna has been chosen. Although a separate antenna winding has its advantages, the condenser-coupling will do away with one coil and, once adjusted, it works satisfactorily. The coils then need only a four-prong base.

A series of five coils will cover the entire range from 15 to 550 meters. The individual ranges of the coils used with this set are as follows: 1. *15-30 meters*, 2. *29-58 meters*, 3. *54-100 meters*, 4, *100-225 meters*, 5. *220-550 meters*.

The use of vernier dials will be found imperative: for sometimes as many as four or five stations may be found within one division.

A metal panel should be used to provide electro-static shielding. When this panel is grounded and the condenser rotors are grounded, "hand-capacity" will be minimized.

The drain on the batteries is rather small; it is possible to employ the smallest types available, keeping weight and size of the outfit

low. A very compact 45-volt battery is now available. Two of these and a small 3-volt A battery are all that is needed.

The construction should not offer any great difficulties. The metal panel should first be prepared and drilled. A panel is available which will fit a suitable carrying case. The two variable condensers, three sockets, the antenna and insulated phone jacks are then mounted on the panel. The r.f. choke and the audio transformer can be fastened to some of the bolts which are used to support the other parts. The grid leak and condenser are supported by the wiring.

The special small B batteries fit in the remaining space below the panel. Batteries should be securely fastened by metal clamps. The reader can add certain conveniences to suit himself, for instance, extra sockets, screwed to the side of the cover, are handy ways of carrying the tubes while transporting the set.

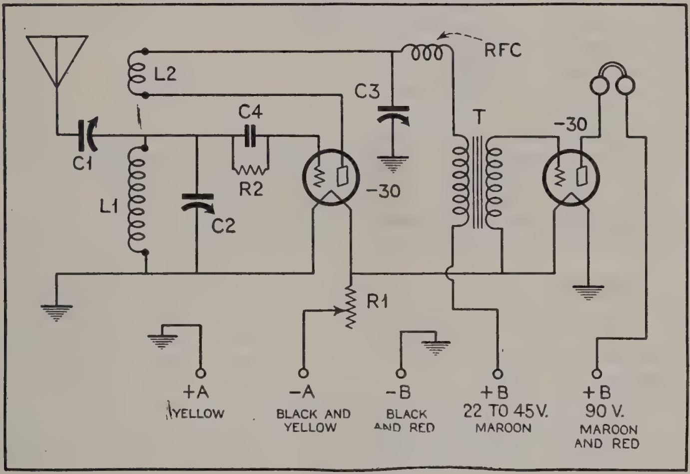


FIGURE 10

It is now generally known that tuning on short waves seems much sharper than on the broadcast band. Therefore, if it is not done patiently and carefully, the layman might tune all through the dial and conclude that the set is not working. Yet the same receiver, handled by an experienced short-wave fan might yield a whole string of foreign stations. In operation the regeneration control should be advanced until the tube oscillates. Then by tuning the other dial, a whistle will be heard for every station. If the whistle remains steady (not Morse code) the station is probably transmitting speech or music. The detector tube should now be brought out of oscillation so that the voice can be heard. It will be found that by varying the regeneration controls the tuning changes slightly and the tuning condenser will have to be reset. In fact, this might have to be done in several small steps to prevent losing the station.

The writer, on this portable, received several European stations such as DJC, EAQ, GSB and most of the American stations which are usually heard on other receivers. Among the police stations, Cleveland, Minneapolis, etc., were brought in clearly.

The antenna-coupling condenser should be adjusted for best results on the antenna being used. Then it need not be touched again. The reader will find it to his advantage not to change this condenser often, for it will change the dial settings.

List of Parts

C1—100 mmfd. Powertest antenna trimmer condenser.
C2, C3—140 mmfd. Powertest variable condensers.
C4—100 mmfd. Powertest fixed condenser.
L1, L2—Powertest set of five plug-in coils, 15-550 meters.
R1—Powertest 10-ohm rheostat with switch.
R-2—Powertest 5-megohm gridleak.
T—Powertest audio transformer.
3—four-prong sockets.
2—Kurz-Kasch 3-inch vernier dials.
1—85 millihenry r.f. choke.
2—insulated phone-tip jacks.
1—Try-Mo carrying case, approximately, 12¼ inches by 8¾ inches by 6 inches, inside dimensions.
1—Try-Mo punched-metal panel, 12¼ by 8¾ inches.
1—"General" battery, 3 volts, type P-2-X.
2—"General" batteries. 45 volts, type V-30-AA.

THE WALLACE TWO-TUBE (BATTERY) RECEIVER

It is possible to build a small, two-tube receiver which will enable the operator to receive as many stations as with a larger set, although not as loudly. For such results, however, great care must be taken not to lose any of the signal strength picked from the air. In other words, all parts and circuits must be efficient as possible and both aerial and secondary circuits should be tuned. This has been successfully accomplished in the receiver here described. This set was designed by Don C. Wallace, well-known amateur owner and operator of W6AM at Long Beach, California. Mr. Wallace's receiving system distinguishes itself from others mainly in the aerial circuit employed. The diagram in Figure 11 shows this; a dipole antenna is used and the double lead-in is transposed. This has proved one of the most effective aerial systems. To take the greatest advantage of the signal, the aerial should be tuned, and while tuning it, the symmetry should not be destroyed. This condition was met admirably by cutting the antenna coupler in the middle and inserting a 43-plate midget variable condenser.

The cutting of the primary results in a coil with eight terminals. The illustration indicates how this is done. The coil mounting has four prongs on the bottom and also a four-prong, wafer socket at the top. The plug fitting in this socket carries two twisted pairs of leads. One pair connects to the two aerial posts, the other pair to the antenna tuning condensers.

Special coils have been made for this receiver. The secondaries of these consist of a silver ribbon wound on a ribbed form. This insures high efficiency. Moreover, an Isolantite socket is employed.

The next point of interest is the main tuning condenser. It consists of two sections on a single shaft—one section of two plates and one of nine plates. The switch S2 enables connection of the condensers in parallel or to have only the smaller section connected. It is obvious that with only the small section in use, a band-spread effect is obtained and the band is located at the lower limits of the coil. For instance, a coil which tunes from 75-150 meters with both condensers may spread the amateur 'phone band all over the dial with the small condenser. If, however, a band-spread effect is desired at another point, a special coil will have to be wound

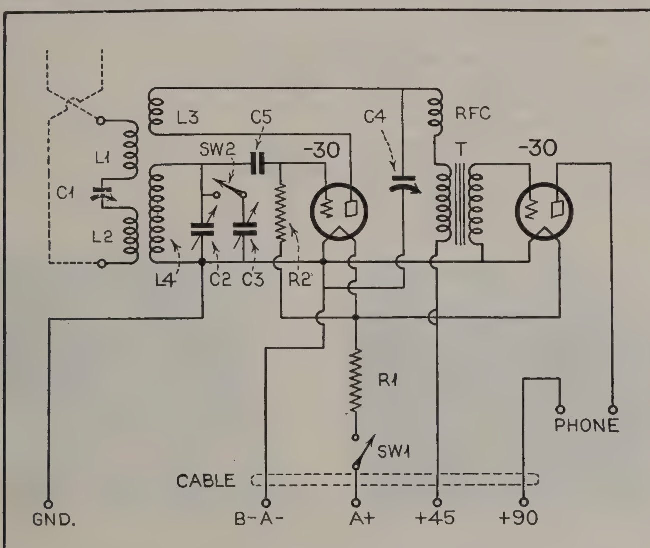


FIGURE 11

for it. The experimenter can prepare such coils himself by the cut-and-try method, adding or subtracting one turn at a time on the secondary.

The set, shown in the illustration in Figures 12 and 13 employs two 2-volt tubes. Their filaments can be wired in parallel and two dry cells, with about 8 ohms in series with them, will light the filaments. It is also possible to employ a 4½-volt C battery for the A supply. In that case, the filaments are wired in series and a fixed resistor of 8 ohms is connected in the circuit.

Operating the set is simple enough. The filament switch (bottom, left) is tuned "on" and the regeneration control is adjusted till a hiss is heard on the 'phones. By slowly rotating the main tuning

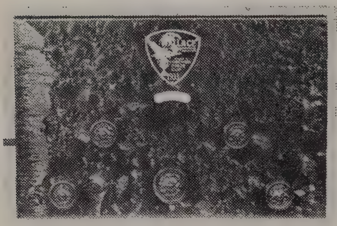
dial you will hear a whistle when a station is passed. If the regeneration control is now tuned lower, the program will come in. So far, this is the procedure for any regenerative receiver. The antenna tuning condenser should then be set to approximately the right place before looking for stations with the main tuning condenser. After some practice, the reader will find where this should be. After a signal has been tuned in, it can be made considerably louder by turning the antenna condenser to the correct position. The regeneration condenser will then probably have to be readjusted slightly.

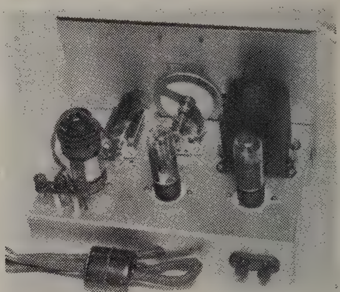
Part List

C1—Hammarlund 43-plate midget condenser, 325 mmfd.
C2, C3—Hammarlund special "Wallace" band-spread condensers, 75 mmfd. total
C4—Hammarlund 34-plate midget condenser, 250 mmfd.
C5—Fixed condenser, .00025 mfd.
L1, L2, L3, L4—Bruno No. 1A short-wave coil
R1—Special filament resistor, 8 ohms
R2—10-megohm grid leak
RFC—Hammarlund Isolantite r.f. choke
SW1, SW2—Powertone sp.s.t. switches
T—Powertone audio transformer

FIGURE 12—BELOW.

FIGURE 13—RIGHT.





3 Hammarlund Isolantite 4-prong sockets
1 panel
1 base
1 vernier dial
1 triple binding-post strip
1 double binding-post strip
1 battery cable (special) with fuse
5 knobs
Other Bruno coils: 2A, 3A, 4A, if desired.

AN ECONOMICAL THREE-TUBE RECEIVER ($12.05)

In constructing this receiver our purpose was to obtain a receiver that would bring in various stations working on the higher frequencies, including the air-mail ground stations and "hams" (phone

and code), along with the numerous short-wave broadcasting stations of the United States and Canada.

We mention $12.05, because that was the initial outlay for all the parts we had to buy. Doubtless the fan building this set will need to purchase some of the parts that we found in the radio junk box,

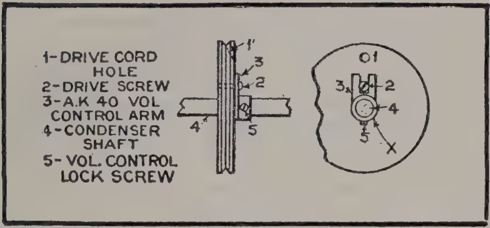


FIGURE 14

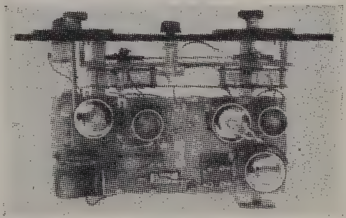
The drawing to the left clearly demonstrates the method for drilling the discs used for the single-control unit.

but this will be offset by the probability that he will have in his own junk box at least some of the parts for which we were forced to pay hard earned cash.

When this little three-tuber was ready for the air, we were agreeably surprised by the performance. Not only did the required air stations come through better than we had hoped, but at noon (Pacific Time), while eating our lunch, we listened to GSB. This station

FIGURE 15

The r.f. stage is at the left front and, to its right, the detector stage. The single audio stage is at the left rear.

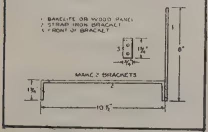


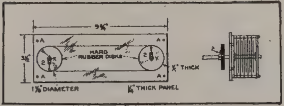
was playing American music which came through with some fading and quite a bit of noise, but the announcement was loud and clear. Considering the lack of shielding and the losses that must be present through various junk parts used, we thought this was very fair reception.

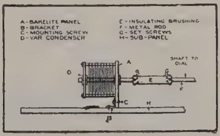
The Parts Used

Many of the parts were taken from an old Fusaformer set that cost us $2.00. This provided the tuning condensers, sockets, etc.

FIGURE 16—LEFT. FIGURE 17—BELOW. FIGURE 18—RIGHT.







The parts we found we needed and which account for the $12.05 outlay are as follows. Twenty-two inches of inch and a quarter (outside diameter) bakelite tubing, $1.25; 1 15-ohm fixed resistor, 35c; 1 50-ohm rheostat, $1.00; 2 condensers, .01 mfd., $1.50; 2 odd panels, 20c; 1 type –32 screen-grid tube, $3.30; 2 used volume-control

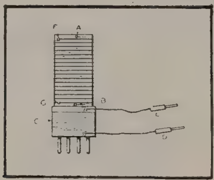


FIGURE 19

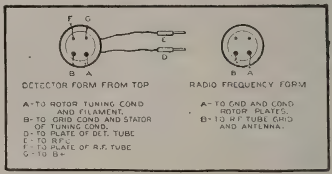


FIGURE 20

arms as taken from an Atwater Kent model 40, cut to shape as in Figure 14 (x) costing us 10c; three feet of ½-inch strap iron, 10c; 1 grid leak, 4 meg., 35c; 1 midget condenser, $1.25, and an old Bradleystat used in the positive leg of the detector plate condenser, 10c. Then in the junk box we found an old nineteen-plate condenser which we used for the capacity unit in the plate circuit of the detector tube.

Several burned-out –01A tubes were deprived of their bases, and these were used for the plug-in coil mountings, then two old panels, reasonably free from holes, were purchased for 10c, along with 2 vernier dials for 60c.

The old Fusaformer yielded the supply of machine screws and nuts, while battery nuts taken from dry cells acted as spacers for the units we wished to mount back away from the main panel.

Now that we have all the parts listed, suppose we go into details on the construction of the various assemblies.

We used the side of a pine box for both the panel and the sub-panel. The section used for a panel was cut to a size of 8 by 14 inches, given a heavy coat of brown Duco on the finished side, and when this had dried thoroughly we gave the opposite side a thick coat of shellac, and after it had started to get sticky we took the foil from an old condenser and covered the back with it, being

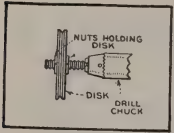


FIGURE 21

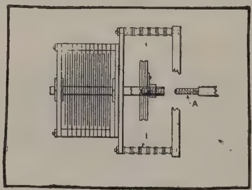


FIGURE 22

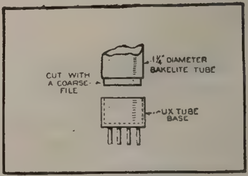


FIGURE 23

careful to lap the strips so there would be a good electrical connection. The sub-panel was cut to a size of 12 by 5 inches, given a coat of shellac on both sides, and when partially dry we gave one

of the sides a coating of the condenser foil and allowed it to dry (see Figure 15).

Two pieces of the strap iron were cut to a length of 14½ inches. bent 1¾ inches from each of the ends, as at Figure 16, and drilled for machine screws to fasten the brackets to the panel and sub-panel. If preferred, two pieces of wood may be used in place of the iron.

Mounting the Tuning Condensers

The condenser panel was cut from an old bakelite panel to the size of 9¾ iches by 3½ inches with four holes drilled in the corners of the panel far enough in to assure plenty of strength to this part for the support of the tuning condensers (see Figure 17, at A).

Discs for single-control unit may be roughly shaped from wood, bakelite, metal or whatever the constructor wishes, with a hack-saw. Dress them to some semblance of a circle with a coarse file, then drill a ¼-inch hole at the center, place a ¼-inch bolt through the hole, fasten the job securely in an electric drill as shown in Figure 21, and hold the same file against the face until the disc comes to a perfect circle. Now with a small three-cornered file, cut the groove to accommodate the cord for driving the two condensers as a single unit, by holding it against the revolving face of the disk.

The finished discs should be placed in a vise, one at a time, drill a hole large enough to accommodate the cord used to drive the condensers, starting at the bottom of the groove and holding the drill at such an angle that it will come out near the screw (2), Figure 14, under which the cord is looped as in Figure 17. The size of screw 2 should be 6-32.

Extending Condenser Shaft

Figure 22 will give a general idea of the extension necessary to bring the drive through to the panel for the accommodation of the vernier dial. The length of this extension will depend on the distance the mounted tuning unit is to be set away from the main panel, but, allowing for a fair margin of safety, this extension should be at least 2 inches in length.

Drill a hole at a depth of ⅜ of an inch, directly down the center of the condenser shaft, with a drill that will allow a deep, clean thread of an eight or a ten-thirty-two tap to be run in, then dress down the end of the piece of metal used for the extension so a die will put a good thread over the part to be threaded. This finished, screw the extension into the condenser shaft, draw it tight, drill a small hole through the completed job and run it full of hot solder. This will form a key that will prevent any loosening between the main shaft and the extension.

Assembling the Tuning Unit

Mount the tuning condensers in their respective positions (at least 6 inches center to center), slip one of the drive discs over each condenser shaft, followed by the old A.K. volume-control arm that

has been shaped as shown in Figure 14 (x). Lock each disc at the volume-control arm as in Figure 17 (x) and (y), set the condensers at their maximum capacity and run the drive cable with the volume-control arms (used as couplers hooking the discs to the shafts) set in the positions shown in Figure 17. Drill the holes in the main panel for the accommodation of this unit, and with the nuts from the old dry cells space the condenser unit the desired distance from the main panel and fasten securely.

This is shown in detail, (Figure 18), with all the data on the assembling and design of the various parts going to make up this unit. A is a small piece of bakelite, D condenser, E insulating bushing used to insulate the condenser from the copper tubing (or metal rod) at F which acts as the extension shaft, G represents 6-32 machine screws that act as clutch and centering screws for the regeneration condenser.

In the assembling of this receiver a 50-ohm fixed resistor is fastened directly to the negative terminal of the radio-frequency tube socket with a 50-ohm rheostat in the positive side. This rheostat is mounted on the under side of the sub-panel, with the shaft sticking through so the proper setting may be secured without disturbing the set proper. Then from the arm of the rheostat the wiring may be run directly to the filament switch and then to the A battery positive, bringing the grid return of the r.f. tube to the A— end of the fixed resistor to give the proper C biasing for the radio-frequency tube.

Owing to the smallness of the coil forms, there may be a little difficulty encountered in getting the windings down through their respective prongs as the forms are wound. However, we used a pair of long-nose pliers with very satisfactory results.

If desired, the tubing of the antenna coupler and the detector units may be wound before the two sections are cemented together.

Directions will be given for the winding of one set of coils, with the length of tubing, number and kind of wire and the size, other units may be wound at will to cover all the frequencies desired by the builder.

Give the inside, open end of the tube base a heavy coat of the Duco cement and press the tubing used for the winding of the inductance firmly into the base before the cement has had time to set. Allow this to dry and place the form in a vise so the large or filament prongs of the tube base are toward the constructor. (By using about a number 28 drill there will be plenty of clearance for any of the sizes of wire used in the construction of the coils.) Now to get on with the directions for the winding of the forms. Drill a hole at the top and as near the edge of the form as is convenient, slightly to the right of the form center, then 1⅝ inches lower drill another hole of the same size just to the left of center.

Positions for the ends of each winding are shown in Figure 19 at A and B for both the antenna coupler and the detector unit, with Figure 20 showing the relation of the ends of the windings to the prongs of the tube bases for both the detector form and the r.f. coils.

We used the four-prong bases and sockets for the reason that they were on hand; however, if the constructor desires, he may use any of the many coil mountings and forms found on the market,

being sure to bring the grid, plate and tickler windings to their respective positions as found in the diagram of the circuits in Figure 24.

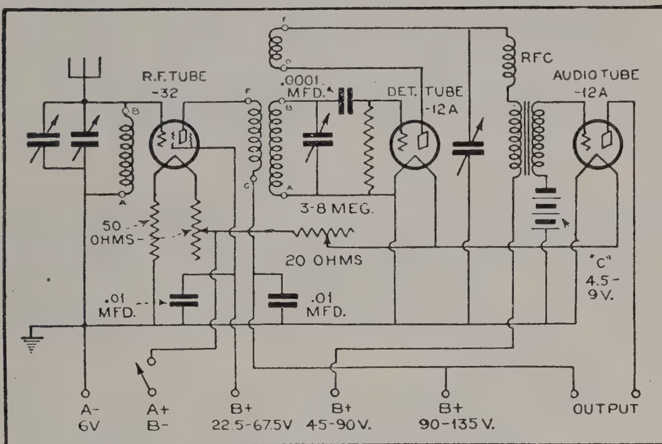


FIGURE 24

Above is the circuit diagram for this economical receiver.

Tip Jacks for the Tickler Coil

Owing to the fact that we used the four-prong tube bases for the coil mountings, it was necessary to bring the tickler coil out with two pig-tails equipped with phone tips and plugging each into pin jacks. The position of this winding is found in Figure 19 at C, showing the ends of the winding at D and E in the same chart.

All tickler windings are of number 30 d.c.c. unspaced and wound ⅛ inch below the grid windings. The ends go to the solder lugs and the pig-tails brought from there to the pin jacks.

Table for Three Sets of Coils

Antenna Coils

Length of Tubing	Wire Size	Number Turns	Kind of Wire
2¼ inches	22	17	Enameled
2¾ inches	22	27	"
3¼ inches	26	46	"

Interstage Coil Secondary
(Spaced—Nos. 1 and 2, 1/16 inch;
No. 3, 1/32 inch)

2¼ inches	22	17	Enameled
2¾ inches	22	27	"
3¼ inches	26	46	"

Interstage Coil Primary
(*Wound between turns of grid coil*)

2¼ inches	30	17	Enameled
2¾ inches	30	27	"
3¼ inches	30	46	"

Interstage Coil Tickler
(⅛ *inch from lower end of grid, unspaced*)

....	30	11	d.c.c.
....	30	9	"
....	30	20	"

In considering the various sizes of wire that might have been used, we noted very little difference in the frequencies covered using several different sizes, selectivity was almost identical and the volume the same, but when we came to get into the variations of the spaced and the unspaced, we found a remarkable difference, the spaced winding having more volume combined with greater ease of handling and no dead spots, while the opposite was noticed on the coils wound with all inductance unspaced.

If the operator should desire to wind a greater variety of coils, for the lower or higher frequencies, the spacing between the turns for the higher frequencies should be about 1/16 of an inch, while that for the lower frequencies should be 1/32 of an inch.

This holds until coils for the broadcast band are to be wound, when the wire may be wound unspaced as on any of the commercial broadcast sets.

Notes on Operation

Although the diagram of the circuits, Figure 24, shows a radio-frequency choke in the plate circuit of the detector (150 turns of number 30 d.c.c. wire on a ½-inch dowel) the set worked very satisfactorily without it; however, with the r.f. choke in the B positive of the detector, there was a total absence of dead spots, and the regeneration condenser turned in a little at a time as we advanced toward the upper end of the dial readings.

When putting the finished set into operation, set the filament of the –32 r.f. tube at about 1½ volts for a trial, as this is the spot where the tube furnished us worked the best; if necessary, the voltage may be increased to the rated value.

We also found that 22½ B positive on the screen grid, with 67½ volts to 90 volts on the plate, gave us better reception when the Q.R.N. was bad, while with normal conditions we were able to use 45 on the screen grid, with the customary 135 on the plate.

The tube used in the detector socket was a type –12A. This gave more volume with lower plate voltage than any of the other types of tubes tried including the –40 and the –01A.

In case there might be some slight difficulty in the symtoms developed by the receiver, let us give the layman some idea of where to better his reception. Suppose that when the set is put in the air, the operator is unable to stop the oscillating of the detector circuit, while turning the tuning dial from 0 to 100. In the first

place be sure the capacity of the feed back condenser is set at the 0 position, then lower the plate voltage of the detector tube; if the trouble still remains it will be necessary to take turns from the tickler coil, one or two at a time, until the set becomes stable.

On the other hand, if there should be no indication of an oscillating condition, a higher grid leak resistance, reversing the tickler coil windings, and building up the plate voltage might be tried. If none of these operations brings the desired results, you will have to add more turns to the tickler coil.

AN A.C.-D.C. UNIVERSAL THREE-TUBE SET

The past six months have proven without any doubt the popularity of the universal type of broadcast receiver. The same principle of universal receiver design employing the new type vacuum tubes is now being applied with equally successful results to the short-wave receiver. The "Prizewinner" a.c.-d.c. three-tube short-wave receiver described in this article is truly a universal short-wave set.

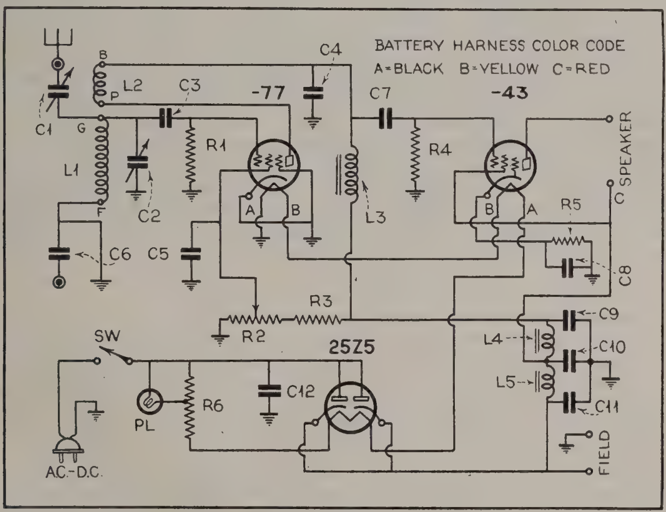


FIGURE 25

It is designed for operation on either 110-volt direct or alternating current (50-60 cycle) or, by the use of a battery cable which connects to the points as indicated in the schematic wiring diagram, Figure 25, it can convert the circuit for battery operation.

The universal application of this receiver and the excellent sensitivity and volume (for a small set) that it is capable of providing is made possible by the employment of the new tubes, comprising the –25Z5 full-wave type rectifier, the new –77 bias detector and the –43 type power-amplifier tube. There is nothing complicated in the

construction of the receiver and the cost of the parts is under $10.00. The receiver incorporates its own power supply, and an idea of its compact size may be had by noting the cabinet dimensions (11 inches long by 6½ inches deep by 7 inches high).

While the receiver is intended primarily for headphone reception, it is capable of operating a magnetic type speaker or a dynamic type reproducer on local stations. The set functions well when connected to a 10-inch size dynamic type speaker. In this case, the speaker incorporates its own rectifying system, operating from 110-volt, 60-cycle line supply. However, a dynamic type reproducer with a field winding of approximately 4000 ohms can obtain the necessary exciting current for its operation, direct from the receiver power supply. The field winding is simply connected across the cathode to ground circuit of the –25Z5 rectifier, as shown in the schematic wiring diagram, Figure 25.

Where the set operates on direct or alternating current, the heaters of the tubes are connected in series. This offers no complication, as all three tubes operate at 0.3 ampere current. A wire-wound resistor of 175 ohms, connected in series with the heater circuits of the tubes, is used to absorb the excess voltage. To light the pilot lamp, this resistor is tapped 30 ohms from one end and the pilot light is connected across the tapped resistance.

The circuit consists of a standard regenerative detector, with a conventional grid leak arrangement, employing the –77 type tube. The antenna is capacitively coupled to the detector circuit. The impedance-coupled audio-amplifier stage uses the –43 pentode type power tube. An effective two-section, power-filter system is used with high-capacity filter condensers and well-designed chokes.

There are four plug-in coils to cover the entire short-wave band from 14 to 195 meters. The coil data appears in Figure 26. A word

COIL DATA

COIL FORMS : 1¼-Inch diameter, 4 prong type.

ALL WINDINGS close wound except "A". Spacing on "A" equal to diameter of wire. ALL WINDINGS wound in same direction.

WAVELENGTH METERS	GRID		TICKLER		
	Type of wire	Turns	Type of Wire	Turns	Separation
"A" 14 TO 35	No. 20 Enam.	5	No. 28 SCC	3	5/32"
"B" 34 TO 63	No. 20 Enam	11	No 28 SCC	4	5/32
"C" 62 TO 112	No. 24 SCC	19	No. 28 SCC	5	1/8"
"D" 110 TO 195	No. 26 SCC	48	No. 28 SCC	7	3/32"

FIGURE 26

here, in reference to the construction of the coils, will not be out of place. The position of the tickler coil should be kept as far away from the grid coil as possible, without the circuits dropping out of oscillation. The distance as outlined in the coil data will be correct for most of the inductances.

In reference to the physical construction of the "Prizewinner," the reader can refer to the schematic wiring diagram, Figure 25, and the top view of the set, Figure 27, which shows the proper placement of most of the parts.

When the receiver is operated on direct-current supply, it is necessary to observe "polarity." If the set does not produce a signal after a minute or so, reverse the line plug and the receiver should

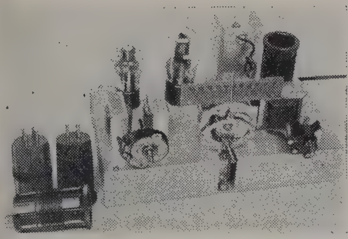


FIGURE 27

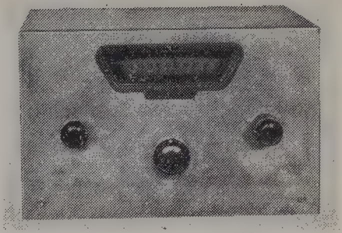


FIGURE 28

work immediately. If the set is to be operated from batteries, a special harness cable is connected to the points indicated in the schematic wiring diagram, Figure 25. Then the –25Z5 rectifier tube is removed, as it is not employed. The –41 type power tube is substituted for the –43 type tube. The battery cable is connected according to the color code on the drawing. This cable connects the two tubes in parallel so the heaters can be operated on 6 volts. The B supply should be approximately 135 volts.

To prevent any danger of a short-circuit in the line, a condenser of .01 mfd. is connected between the ground binding post and the receiver chassis. The ground lead *should never be connected direct to the chassis.*

To obtain best results from a short-wave receiver, some attention should be given to the antenna installation. Good insulation of the aerial is essential. The antenna length found to be desirable in most locations is 60 to 70 feet. The parts list is given below, showing individual items, although a complete kit is available.

List of Parts

C1—40 mmfd. midget condenser
C2—165 mmfd. variable condenser
C3—.0001 mfd. mica condenser
C4—.0002 mfd. mica condenser
C5—.5 mfd. condenser, pigtail type
C6, C7, C12—.01 mfd. condensers, pigtail type
C8—10 mfd. electrolytic condenser
C9, C10—8 mfd. each, electrolytic condenser
C11—16 mfd. electrolytic condenser
L1, L2—Plug-in coils (set of 4 coils)
L3—Audio impedance
L4—25-henry choke
L5—15-henry choke
R1—5-megohm resistor
R2—50,000-ohm potentiometer
R3—60,000-ohm resistor
R4—250,000-ohm resistor
R5—625-ohm resistor
R6—175-ohm resistor
SW—Power switch on R2

3 wafer sockets, 6-prong
1 wafer socket, 4-prong
1 vernier illuminated dial
1 stamped metal chassis
1 metal cabinet
1 terminal strip
1 duel antenna and ground binding-post strip

AN IMPROVED DON WALLACE S.-W. RECEIVER

Short-wave enthusiasts who have constructed Don Wallace's two-tube, battery-operated receiver, and have found out for themselves the short-wave reception results that this circuit is capable of providing, will read with interest the present article on the Wallace four-tube a.c.-operated receiver and the instructions and circuit diagram for converting their battery receivers for a.c. operation.

The receiver should find many new friends with both broadcast and short-wave constructors, as they will note the simplicity of the job herein described, showing that there is nothing complicated in its assembly and construction. The power supply, with automatic voltage regulation, is a separate unit that simplifies the conversion of the two-tube battery receiver for a.c. operation. Another advantage of a separate power unit is that it reduces the possibility of hum.

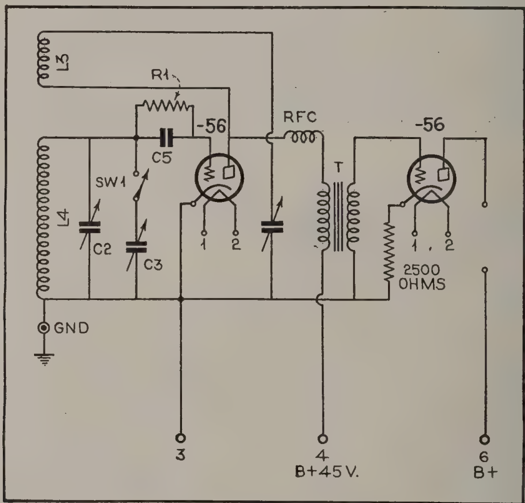


FIGURE 29

This power pack, although designed for the Wallace receiver, will, of course, provide equally good results when used with any type of short-wave or standard receiving set.

It is the main purpose of this article to deal with a discussion of the four-tube a.c. short-wave receiver, but, as mentioned above, for those who desire to convert their battery jobs it only will be necessary to refer to the circuit diagram in Figure 29 to note the small changes involved. The type –30 tubes are replaced by the –56 type and a bias resistor is placed in the cathode lead of the audio-frequency tube to supply the bias voltage. This converted d.c. receiver and the four-tube set use a six-conductor connecting cable terminating into a 6–prong type socket on the power chassis for carrying over the necessary operating voltages. Transformer-coupled audio amplification is used for the converted receiver.

The Wallace four-tube a.c. set, as illustrated and as shown in Figure 30, employs the type –58 super-control r.f. amplifier tube for

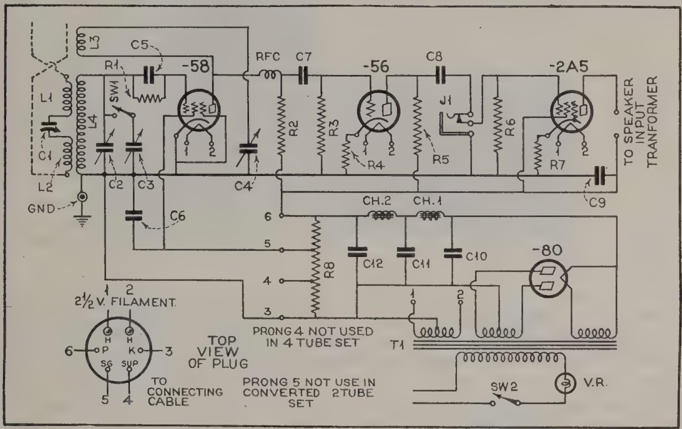


FIGURE 30

the tuning circuit, one –56 type tube for the first audio-frequency stage and the new type –2A5 power tube for the output stage. This –2A5 tube is capable of providing 3 watts of power output. The tuner is the same as described for the battery set using the tuned antenna system for transposed feeder lines. This has proven to be a very effective aerial system, especially for short-wave reception.

The special tuning coils have four prongs at the bottom for the connecting leads to the grid and plate circuit and on top of these forms there is a 4-prong socket into which a plug fits to carry over two pair of twisted leads. One twisted pair connects to the aerial posts and the other pair to the antenna tuning condenser C1. The secondary windings of these plug-in short-wave coils are wound with flat silver ribbon wire on a moulded-ribbed bakelite form.

The tuning condensers comprise two sections on a single shaft; one section is of nine plates, C3, and one is of two plates, C2. With the switch SW1, it is possible to connect both condensers in parallel or to have only the smaller section connected. In this arrangement, where only the two-plate condenser is in the circuit, a band-spread

effect is obtainable. Isolantite sockets are utilized to advantage in the receiver chassis.

The audio-frequency end of the set employs resistance-coupled amplification with a type –56 tube in the first stage followed by the type –2A5 power tube. For headphone reception the jack J1 is connected in the grid circuit of the second tube.

The power supply is equipped with the Amperite 5-A-5 voltage-regulator tube, employs the type –80 rectifier and is designed with a two-section filter system, using two 30-henry choke coils and three electrolytic type condensers, each of 8-microfarad capacity. By referring to the illustration, it will be noticed that the filter con-

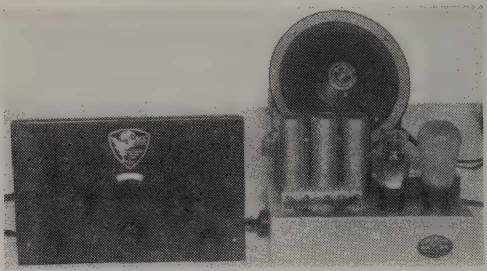


FIGURE 31

densers are mounted between the bleeder resistor and the choke coils. The power transformer, T1, can be seen in the back of the rectifier and the voltage regulator tubes. The dynamic speaker shown in the photograph contains its own power supply, operating off the a.c. line. However, there is no trick in using a standard d.c. speaker having a 1600-ohm field winding and obtaining its operating current from the receiver power pack.

The assembly and construction of both the receiver and the power supply is simple, as is obvious by referring to the illustration and diagrams.

Operation

In operating the set, the regeneration control is to be advanced till a hiss is heard in the phones or the speaker. Then slowly rotate the main tuning dial until you hear a whistle when a station is passed. The regeneration control should now be retarded and the program should come in with clearness and volume. The antenna condenser C1 should be set approximately at the right place before looking for stations with the main tuning condenser. With a little practice the operator can locate the best point.

The following parts comprise a kit for the Don Wallace 4-Tube A.C. Short-Wave Receiver.

Parts List

C1—43-plate midget condenser, 325 mmfd.
C2, C3—Special "Wallace" band-spread condenser, 75 mmfd., total

C4—34-plate midget condenser, 250 mmfd.
C5—Fixed condenser, .0001 mfd.
C6—.1 mfd. 200-volt tubular condenser
C7, C8—.01 mfd. 200-volt tubular condensers.
C9—8 mfd., 250-volt electrolytic condenser
C10, C11, C12— 8 mfd., each, electrolytic condensers
Ch1, Ch2—30-henry, 300-ohm chokes
J1—Phone jack
L1, L2, L3, L4—Special "Wallace" short-wave coils
RFC—Radio-frequency choke
R1—5-megohm grid leak
R2, R3, R6—250,000-ohm resistor
R5—50,000-ohm resistor
R4—2500-ohm resistor
R7—500-ohm resistor
R8—20,000-ohm resistor, 50 watts
SW1, SW2—s.p.s.t. toggle switch
T1—Power transformer
2 Isolantite sockets, 6-prong
1 Isolantite socket, 5-prong
1 Isolantite socket, 4-prong
2 wafer sockets, 4-prong
1 wafer socket, 6-prong
VR—Voltage-regulator tube, type 5A5
Panel and base for receiver
Base for power pack
1 vernier dial
1 triple binding-post strip
1 double binding-post strip
1 connecting cable with plug

CHAPTER 4

Two Advanced Short-Wave Designs

THE "DISCOVERER FIVE" TUNED R.F. SHORT-WAVE SET

IN designing a short-wave set as much skill is required in rejecting impractical, unworthy ideas as in selecting and including desirable features. This alone is enough to differentiate the correctly engineered set from the 57 other varieties.

Here are a few of the special features which contribute to the effectiveness of "The Discoverer." The newest and most efficient tubes are employed. Plug-in coils of special design add to the effectiveness of the circuit. Four pairs of coils are used to cover the short-wave band from 10 to 200 meters. High-gain coupling is employed between the r.f. stage and the detector. The set is adequately and completely shielded. The chassis strongly built of steel with cadmium finish. A handsome gun-metal finished cabinet improves the appearance and aids shielding. Single-dial control gives easy tuning. Finally, the set is easy to assemble and wire, and a complete kit is available

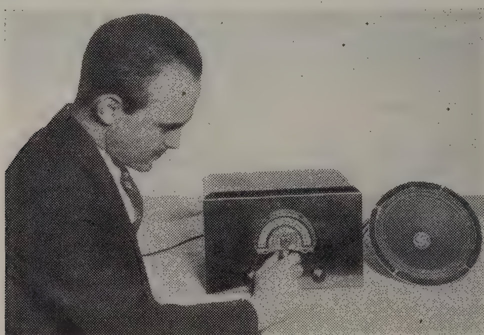


FIGURE 32

so that it is not necessary to waste time shopping around for the specified parts.

Basically, the circuit of the Discoverer consists of a tuned r.f. stage, a tuned "grid-leak-condenser" detector stage with regeneration, a resistance-coupled first audio stage, and a resistance-coupled output stage. The r.f. stage uses a variable-mu –58 tube. A –58 tube is also employed as the detector. Regeneration is obtained by connecting the cathode of the detector tube to a tapped point in the secondary of the r.f. transformer L2. The tap is made at ⅓ the number of turns, counting from the ground end.

This type of regeneration gives smooth regenerative action, with full, even control. It also has a very important advantage that changing the position of the regeneration control does not detune

the set. The variable resistor R5 controls regeneration by changing the detector screen-grid voltage.

Condenser C9 and resister R8 act as a resistance-capacity filter for reducing hum in the detector stage. The r.f. choke L3, by-passed by condenser C8, keeps the r.f. currents out of the audio circuit. The result is humless operation, even when earphones are inserted at the jack J1.

The first audio stage employs a general-purpose –56 tube, which feeds into the –59 power output tube. This latter tube, being a pentode of the indirect heater type, gives low hum output. Furthermore, it has greater power and sensitivity.

The phone jack, J1, is connected so that the grid bias on the –59 is not disturbed when using the phones. In other words, the grid circuit is always closed. No direct current flows in the jack terminals, so that there is no chance of getting a shock at this point.

The power supply is more or less conventional, using an –80 rectifier tube. The speaker field serves the dual purpose of filter choke and bias resistor for the –59 tube. The 1800-ohm field is tapped at 300

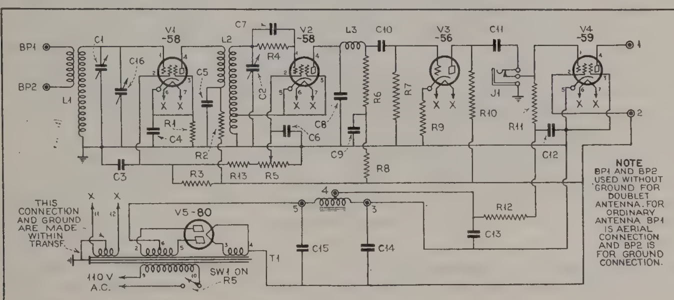


FIGURE 33

ohms and the voltage drop across this smaller section gives the correct negative bias voltage. The two 8 mfd. electrolytic filter condensers, C14 and C15, are combined in a single can.

The metal chassis is available bent to shape and with wafer sockets V3, V4, V5, speaker connection socket and binding-post strip riveted in place. The balance of the assembly is left to the builder. The four Isolantite sockets V1, L1, V2, L2, are fastened into position. The tube shield bases for V1 and V2 are put into place at the same time. The dual variable tuning condenser C1, C2 is equipped with stay bolts, so that the bolts can be slipped into the holes provided for them in the chassis and fastened securely. The condenser is mounted and then the dial. A single bolt on the front chassis wall holds the dial in place.

The small variable condenser C16 is mounted at the right of the front chassis wall. The regeneration control R5 is at the left. The phone jack J1 is mounted on the rear chassis wall, as shown.

The power transformer T1 is mounted next, being placed in a position such that the 110-volt lugs are towards the rear of the chassis. A small bakelite terminal strip is mounted beneath the chassis

¾ inch from the underside, near the outlet hole provided for the 110-volt supply cable, and the latter is firmly anchored to this strip. The dual electrolytic condenser C14, C15 is mounted next.

The long metal shield plate "C" is fastened to the top of the chassis as indicated, and the two smaller shield strips are then fastened at right angles to this and to the chassis.

Fixed resistor R4 is soldered to the terminals of mica condenser C7 and the latter is then fastened to the side of shield plate "A" as shown.

The r.f. choke L3 is fastened underneath the chassis, using a 2¼-inch bolt, which also serves to fasten the socket of V2. All other parts are soldered in position during wiring.

Flexible solid hook-up wire is recommended. The usual order of procedure should be followed. Filament circuit first, then grid circuit, plates, cathodes, by-pass condensers and negative returns, filter system and power supply. Special care should be taken to make connections to socket terminals exactly as shown in the sketches.

The "Discoverer Five" uses a simple tuned r.f. circuit, where the only extra adjustment required is that of the antenna trimming condenser C16. After the preliminary testing has been accomplished, the set can be placed in the metal cabinet furnished with the kit, the antenna and ground connected and tubes and coils inserted in the proper sockets. The speaker should be plugged into the 5-prong wafer socket mounted on the rear of the chassis before the power supply is turned on.

The regeneration control knob should be turned slightly to the right, closing the a.c. power switch. Time should then be allowed for the tubes to heat up. The regeneration control should then be advanced about one-quarter the way until a squeal is heard in the loud speaker. If the squeal is not perceptible, slowly rotate the small antenna trimming condenser until the two main tuning circuits are in exact resonance. This will produce a rushing sound in the

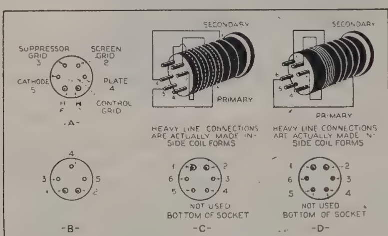


FIGURE 34

The numbers correspond with the numbered terminals in Figure 33.

speaker. As the small trimming condenser is turned and the antenna circuit is brought into resonance with the detector tuning circuit, it should be necessary to turn the regeneration control to the left, due to the excess of oscillation or regenerative action. If the regeneration control is advanced too far, it becomes impossible to obtain the regenerative action, and as this condition varies with the different bands, it is necessary to have a regeneration control which is capable of covering all of the variations due to the difference in coil characteristics for the various bands.

The antenna trimming condenser C16 should be constantly adjusted to exact resonance when tuning for weak or distant signals. The operator will note that the smoothest control of regeneration will

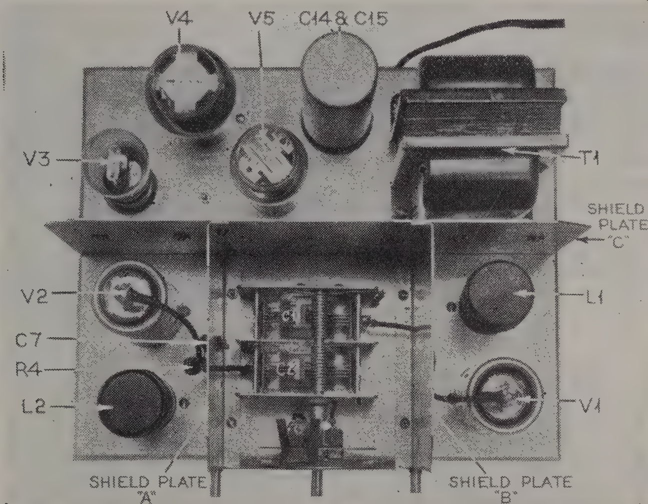


FIGURE 35

occur when the antenna and detector circuits are tuned to exact resonance and the regeneration control is backed off a trifle from the point of maximum regeneration.

In practice, this receiver works in a slightly different way than that ordinarily ascribed to regenerative circuits. In its essence the action can be described as follows: The detector tube is constantly oscillating, and is pulled out of oscillation by means of the regenerative control. There are two factors which govern this action; one is the power absorbed from the detector circuit by the preceding stage. This power is considerable, due to the fact that the plate coupling coil in the r.f. stage has a turns ratio of 66% of the total winding and is very closely coupled. Further, the reduction of the applied voltage to the screen grid of the detector tube will tend to pull the tube out of oscillation.

In the ordinary regenerative receiver the tube is pushed into oscillation by means of energy fed back from the plate circuit to the grid circuit or some other similar means. The fundamental action is that of a stable tube and the tube is actually forced into oscillation by means of any one of these commonly known methods.. In the receiver we use the opposite principle, wherein the tube is constantly oscillating and has to be pulled out of oscillation for voice reception or music. Therefore, keep the antenna trimmer condenser C16 constantly tuned to resonance. Turn the regeneration control

dial and after the whistle of an incoming carrier has been heard, carefully adjust the main tuning control and adjust C16 for absolute resonance. Then you will find that you can advance the regeneration control with the resultant greater signal output.

Parts List

BP1, BP2—Dual antenna ground binding-post strip
C1, C2—Acratest two-gang variable condenser, .0001 mfd. each section, model No. 6708
C3, C4, C5, C10, C11—Acratest .02 mfd. 300-volt cartridge condensers, model No. 2817
C6—Acratest .5 mfd., 200-volt condenser, model No. 2836
C7, C8—Mica condensers, .0001 mfd., model No. 6630.
C9—Acratest 2 mfd., 400-volt electrolytic condenser, model No. 6665
C12—Acratest .1 mfd., 200-volt condenser, model 5637
C13—Acratest 25 mfd., 25-volt electrolytic condenser, model 6646
C14, C15—Acratest dual 8 mfd. electrolytic condenser, model No. 7735

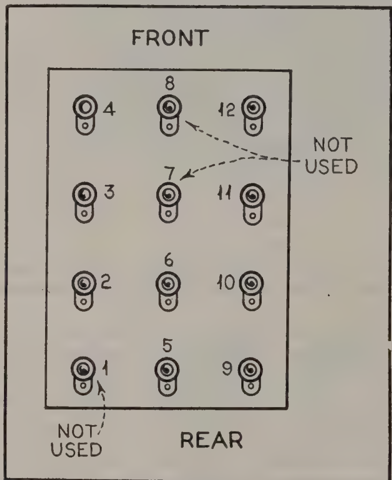


FIGURE 36

To the left is shown the terminal block of the power transformer, T1, shown in the lower left-hand corner of the circuit diagram, Figure 33.

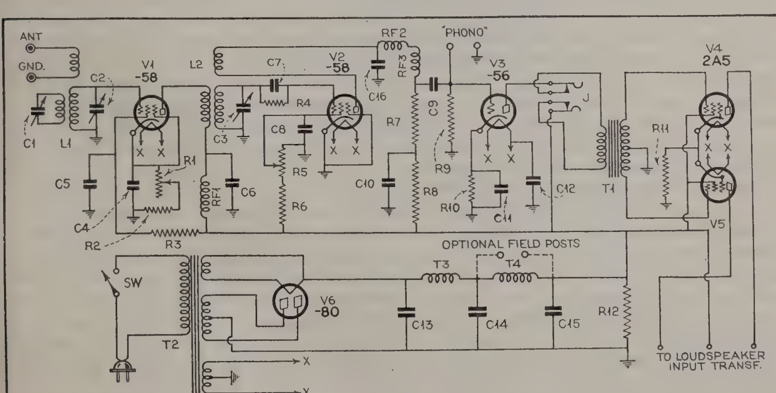
C16—Midget variable condenser, 25 mmfd., model No. 5256
J1—Phone jack "Discoverer"
L1, L2, V1, V2—Acratest 6-prong wafer type Isolantite sockets
L3—Acratest short-wave r.f. choke, model No. 6755
R1—Acratest 300-ohm resistor, model No. 5660
R2, R9—Acratest 2000-ohm resistors, model No. 5660
R3—Acratest 25,000-ohm resistor, model No. 5660
R4—Acratest 3 meg. resistor, model No. 5860
R5, SW1—Frost 25,000-ohm potentiometer (R5) and switch (SW1) model No. 6745
R7, R11—Acratest .5 meg. resistors, model No. 5660
R8—Acratest .1 meg. resistor, model No. 5660

R10—Acratest 50,000-ohm resistor, model No. 5660
R6, R12—Acratest .25 meg. resistor, model No. 5660
R13—Acratest 25,000-ohm resistor, model No. 5660
T1—Acratest power transformer, model No. 6757
V1, V2—Type –58 tubes with sockets (specified above as V1, V2)
V3—Type –56 tube with 1 Acratest 5-prong wafer type socket, type 4063
V4—Type –59 tube with 1 Acratest 7-prong wafer type socket, type 7524
V5—Type –80 tube with 1 Acratest 4-prong wafer type socket, type 4062
1 illuminated full-vision vernier tuning dial pilot light and escutcheon, model No. 7174
1 Acratest 5-prong wafer type 4063
2 Acratest tube shields, model No. 7270, for V1 and V2
1 drilled metal chassis, cadmium plate, 11½ inches by 9⅜ inches by 2 inches high
1 power supply cord and plug, model No. 7304
2 screen-grid clips, model No. 3872
3 small knobs
1 set of 8 special "Discoverer" short-wave coils
1 5-prong speaker plug, model No. 5869
1 dynamic speaker with 1800-ohm field tapped at 300 ohms, model No. 497
1 ornamental metal cabinet, gunmetal finish, hinged cover, 11⅝ inches by 9½ inches by 7 inches high.

THE "SHORT-WAVE MASTER 6"

One of the outstanding phenomena of 1933 radio history has been the startlingly revived interest in home set building, brought about mainly by the growth of the short-wave "game." People everywhere are buying parts, studying hook-ups and neglecting their business

FIGURE 37



their friends and their families in their search for elusive foreign low-wave phone stations. The old DX fever of eight and ten years ago is again rampant and has afflicted many former radio fans and constructors who have not touched a soldering iron in years, as well as newcomers who are just discovering radio to be the ideal hobby it has always been for countless "hams."

The vagaries of short-wave transmission, the uncertainty of broadcasting schedules and the generally unsettled nature of high-frequency technique, are just what are making the short waves so interesting. Logging certain foreign stations is very much a sporting proposition, akin to making a hole in one, and that is what maintains a radio fan's curiosity and attention at fever pitch, not only for weeks, but for months and years.

The people entering the short-wave game at the present time are particularly fortunate in that they have a wide choice of parts, circuits and accessories. There is little of the confusion and blind groping that marked the early days of the broadcast business, and the constructor now really gets a fair return for his investment in equipment. The short-wave field in particular has benefited by the recent avalanche of new tubes, which otherwise has distressed the broadcast set business. It is now possible to build stable, fairly simple short-wave receivers that are highly sensitive and selective and that operate a loudspeaker with a comfortable margin of reserve power.

A representative receiver of the new crop is the New Short-Wave Master 6, described herewith for the first time. This is a thoughtfully designed kit job brought out to meet the special requirements of the many people who want to enjoy the fun and thrill of building their own short-wave set, but who are not capable of or do not have the facilities for performing a great deal of tedious machine work on metal shields and chassis. The day of the wooden baseboard set is definitely over, and the practice today is to use metal construction, for reasons of both electrical necessity and physical appearance.

The Short-Wave Master 6 is a little different from other kit sets in that the cabinet is supplied as a completely finished unit, with all shield partitions welded in place. Accurate mechanical fitting of all the parts is thus assured. Both top and bottom are quickly removable, leaving the inside fully accessible for all the assembly and wiring operations. Measuring 12½ inches wide, 8¾ inches deep and 8½ inches high, the cabinet is finished in mark-proof black crackled enamel and presents a professional, factory-built appearance of which the builder will be proud. The top, of course, is hinged to permit quick changing of plug-in coils.

The power pack is built as a separate little unit measuring 9¼ inches long and 6¾ inches wide and 5½ inches high overall. Connection between the receiver and the pack is made by a convenient plug-and-cable system. The pack was made separate from the tuner because a separation of several feet between the units contributed noticeably to the quietness, stability and general flexibility of the outfit. Furthermore, the absence of the extremely heavy power transformer, filter chokes and filter from the receiver chassis makes the latter easier to handle.

Electrically, the receiver comprises one stage of tuned radio-

frequency amplification, employing a type –58 tube, V1. (See the complete schematic diagram, Figure 37, for parts markings.) This tube, the antenna plug-in coil L1, the tuning condenser C2 and the trimmer C1, occupy the left-hand compartment of the cabinet. The r.f. tube works into a regenerative detector V2, another type –58. This tube, the detector plug-in coil L2, the tuning condenser C3 and the regeneration control potentiometer R5, occupy the right-hand compartment. The detector is resistance-capacity coupled to a type –56 first audio stage, V3, which in turn feeds into a push-pull Class A output stage using two type 2A5's, V4, V5. The power pack is of orthodox construction and uses the reliable type –80 rectifier, V6, in a full-wave circuit, with plenty of filter action supplied by the chokes T3 and T4 and the filter condensers C13, C14, C15. Resistor R12 is merely a 12,000-ohm bleeder put there to protect the electrolytic filter condensers while the tubes are warming up.

The audio components of the set are arranged along the back of the cabinet and are isolated from the sensitive r.f. and detector section by a solid shield that extends the full length of the box.

In addition to the detector regeneration control R5, there is a separate r.f. gain control in the form of R1, which is a 50,000-ohm variable resistor that determines the control grid bias of the r.f.

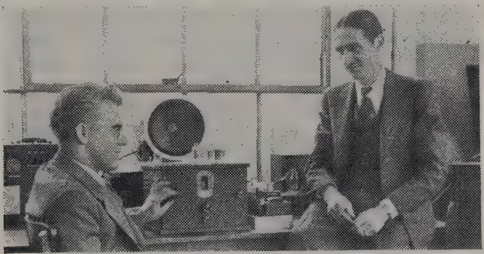


FIGURE 38

tube, V1. This control is combined with a 110-volt, switch which is snapped to "off" when the knob is turned to the zero or minimum volume setting. Two individual leads for the switch are provided in the flexible cable that connects the set to the power pack, so the latter may be mounted out of sight and need neither be seen nor touched.

For the sake of simplicity, the schematic wiring diagram does not show the cable, which contains eight wires: two pairs in parallel for filament supply (to avoid voltage loss through the wires), two for the control switch and one each for "B" plus and "B" minus.

Four pairs of plug-in coils, using Isolantite six-prong forms, give the Master Short-Wave 6 a wavelength range of 14 to 115 meters. Extra coils to reach the broadcast band are also available separately. It is an interesting fact that the two coils of each pair are identical, obviating the care usually required in seeing that the r.f. coil is plugged into the r.f. socket, etc. The four pairs of coils supplied with the set tune as follows with the 90 mmfd. variable condensers C2 and C3; red dot coils, 14-24 meters; blue, 23-41 meters; black, 38-70 meters; yellow, 65-115 meters.

Each coil contains a secondary of heavy wire, an interwound primary and a tickler in a slot at the lower end. With the coil L1 in the antenna position, the secondary functions as such, but the small "tickler" winding is employed as the primary, while the interwound "primary" is shunted by a 35 mmfd. midget condenser C1 to form a sort of absorption tuning loop for "trimming" purposes. The setting of this condenser is not critical; the correct position for each pair of tuning coils is quickly determined by ear.

The primary winding of L1 is brought out to two separate binding posts, so that a doublet antenna with transposed feeder lead-in may be used if desired. With an ordinary antenna, the lower end of the winding is simply grounded by a jumper to an adjacent post that makes contact with the cabinet.

An earphone jack and phonograph pick-up posts are included. The output of even the first audio stage is sufficient to operate a magnetic speaker quite nicely on many stations. No output transformer is supplied with the set, as this is included on practically all dynamic loudspeakers. The power pack is fitted with two binding posts to which the field winding of the speaker may be connected for field excitation. If this is done, the second choke, T4, may be eliminated and its cost saved.

The assembly of the kit of parts is very simple, as all holes are already drilled in the chassis. The various tube and coil sockets are held by small machine screws; the tuning and trimming condensers and the control potentiometers by their own mounting nuts. The only parts requiring mounting on the underside are the interstage

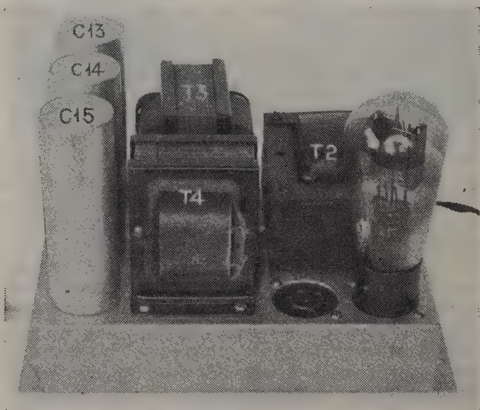


FIGURE 39

transformer T1 and the dial mechanism. All of the fixed resistors, condensers and r.f. chokes are mounted by their own connecting wires as the wiring proceeds. The cabinet may be stood on any side, top or bottom during the assembly and wiring work, a feature that will be appreciated by anyone who has ever put together sets with flimsy,

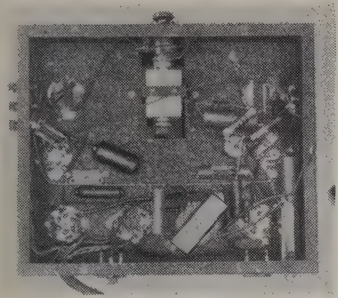


FIGURE 40

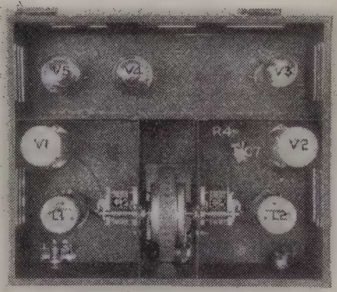


FIGURE 41

wobbly shields. After the set is finished, a bottom plate is screwed on and the top merely slides into its hinges. Plenty of ventilating holes are provided, as the 2A5's become rather hot in normal operation.

The construction of the power unit is simple and is obvious from the accompanying illustrations.

As for results: stories of short-wave DX reception are rapidly getting into the "fish this long" class, but actually the "Master 6" does "pull 'em in." In various locations around New York, where conditions are by no means good, excellent loudspeaker results are enjoyed on such stations as EAQ, Madrid; I2RO, Rome; the various GS-British Empire stations at Daventry; "Radio Colonial," near Paris; the new German stations at Konigswusterhausen, whole flocks of Central and South Americans, the various trans-oceanic radiophones (whenever they use "clear" transmission instead of "scrambled" speech) and even a few antipodal stations such as VK2ME in Sydney and VK3ME in Melbourne, if the operator cares to stay up late enough and watch the sun come over the horizon. There are no tricks in the circuit; it is utterly reliable, and with the aid of the smooth regeneration control it brings in just about everything on the short waves worth hearing. The aim of the designers has been to produce a good set at a reasonable price, and it is believed that this aim has been accomplished.

Parts List

The following list of "Lafayette" parts constitutes the complete kit for this receiver:

C1—35 mmfd. midget condenser
C2, C3—90 mmfd. midget condensers
C4—.1 mfd. mica condenser
C5, C6, C8—1 mfd. electrolytic condensers
C7—.0001 mfd. mica condenser
C9—.01 mfd. mica condenser
C10—1 mfd. electrolytic condenser
C11—25 mfd. electrolytic condenser
C12—.5 mfd. electrolytic condenser
C13, C14, C15—8 mfd. each electrolytic condensers
C16—.00025 mfd. mica condenser

J—Double closed-circuit 'phone jack
L1, L2—Plug-in coils (set of 8 coils)
R1—50,000-ohm resistor
R2—300-ohm resistor
R3—100,000-ohm resistor
R4—5-megohm resistor
R5, R6—50,000-ohm resistors
R7—75,000-ohm resistor
R8—100,000-ohm resistor
R9—500,000-ohm resistor
R10—300-ohm resistor
R11—200-ohm resistor
R12—12,000-ohm resistor
RF1, RF2, RF3—2½ mh. r.f. chokes
SW—Power switch on R1
T1—Push-pull input transformer
T2—Power transformer
T3, T4—30-henry, 100-ohm chokes
V1, V2—Type –58 tubes
V3—Type –56 tube
V4, V5—Type 2A5 tubes
V6—Type –80 rectifier
1 metal cabinet, crackle finish
2 coil sockets, 6 prongs
5 wafer sockets, 6 prongs
1 wafer socket, 5 prongs
1 wafer socket, 4 prongs
2 tube shields (VT1, VT2)
1 6-prong plug
1 8-wire cable
1 double-tip jack
1 vernier illuminated drum dial
2 2-gang binding-post strips
1 2-gang binding-post strip
1 power pack chassis, cadmium-plated steel
1 power cord and plug
1 8-inch dynamic speaker, 450-ohm field, equipped with input transformer for 2A5 tube.

CHAPTER 5

Descriptions of Some Popular Commercially Built Short-Wave Apparatus

A SIMPLE S.W. CONVERTER

AT this time, when so many manufacturers are producing superheterodyne receivers, short-wave fans are wondering whether a receiver of this type can be used successfully with a converter for short-wave reception. This question arises because some converters have not been successful even with a.c. tuned r.f. receivers, probably due to the method of attaching these units to the receiver.

In the past one arrangement was to insert the connecting plug of the converter into the first detector socket of the superheterodyne. As some new sets employ only two intermediate-frequency stages, this method was not satisfactory because the first tuned intermediate transformer is thus thrown completely out of alignment with the other two transformers.

The new adapter, described here, is designed to operate with a.c. screen-grid superheterodyne receivers, working on an intermediate frequency of 175 kc. It's one of sixteen different models of this unit

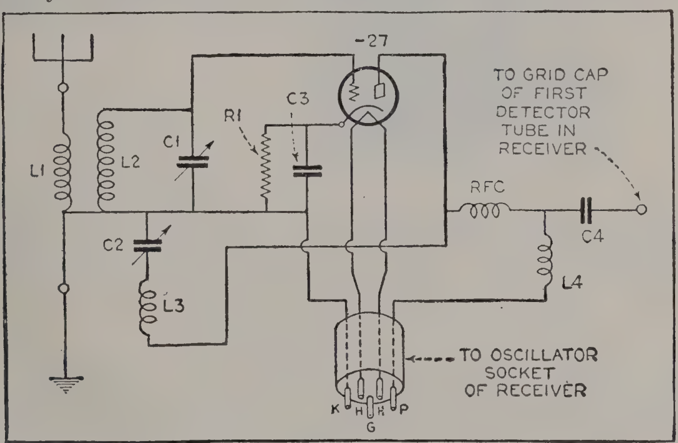


FIGURE 42

that are available for use with any type of a.c. or d.c. operated radio receiver.

The adapter, known as a "Submariner," employs the new "J" feature incorporated within the instrument itself; a coupling device for 175 kc., which with the special connecting plug (shown in Figure 42) inserted in the oscillator socket of the receiver, provides an

arrangement whereby the first detector tube of the set is not discarded as in other short-wave converters, but is utilized in the receiver to function as an additional stage of intermediate-frequency amplification. This method also insures the proper operating voltages for the type –27 tube in the converter, which is employed as a combination oscillator and a first detector. It may be well to state here, since the oscillator tube of the receiver is removed, no troublesome harmonics are encountered from it when tuning the adapter to short-wave stations.

It is a known fact that the screen-grid tube is capable of much higher amplification at low frequencies than at high frequencies. For instance, this tube can produce a gain of 70 per stage at 175 kc. (1725

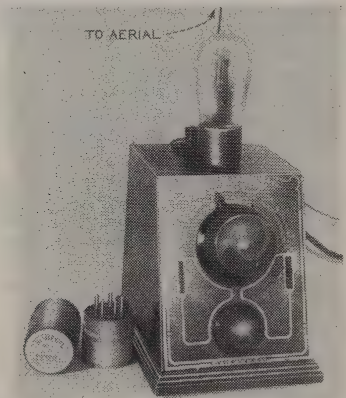


FIGURE 43

This simple and inexpensive adapter employs only one tube and draws all of its operating power through a plug inserted in the oscillator socket of the broadcast receiver.

meters) whereas it will give a gain of only about 5 per stage on 9530 kc. (31.48 meters). This is one of the reasons why short waves are not received as well with tuned-radio-frequency circuits preceding a short-wave detection, without regeneration, as this not only gives a small gain per stage, but adds complexity to the receiving arrangement by employing additional tuning condensers.

In comparative tests it was noted that the new converter, combined with a screen-grid broadcast superheterodyne compared favorably with a specially constructed short-wave superheterodyne receiver.

The interchangeable coils in the converter are of the plug-in type and are equipped with five prongs for insertion in a standard UY-type socket mounted at the rear and close to the top of the device. This order of construction does away with long leads and is instrumental in adding to the efficiency of the unit. The coils are space-wound and each coil form contains all three inductances, L1, L2 and L3. Therefore, in changing from one wave-band to another, it only means changing one coil instead of two or three. The wave ranges of the three coils are as follows: Coil No. 1 (purple), 13 to 30 meters; coil No. 2 (green), 29 to 60 meters; coil No. 3 (blue), 59 to 145 meters.

All parts except the vacuum tube and plug-in coils are enclosed in

a small sloping metal cabinet which provides adequate shielding for the circuit.

INSTALLING THE CONVERTER

Attaching the Submariner to the receiver is a simple matter. First, remove the oscillator tube from the receiver and place it in the socket provided for it on top of the converter. Then insert the connecting cable-plug in the oscillator socket of the set. The control-grid cap of the first detector tube is then removed and in its place is attached the cap on the single wire from the converter. Care should be taken to see that the unused grid cap of the first detector tube does not make accidental contact with any metal part of the chassis.

Next proceed to disconnect the antenna wire from the set and reconnect it to the antenna binding post on top of the converter. A jumper or connecting wire should be brought over from the ground binding post of the receiver to the ground terminal on the unit, thus grounding them both.

This device was designed to operate with practically any type of antenna. However, thirty to fifty feet of aerial will give a satisfactory signal.

The large dial mounted on the face of the front panel controls the condenser C1. The knurled disc to the right of this dial is part of a mechanism associated with this tuning dial to provide a vernier adjustment with a ratio of 64 to 1. The condenser C2, which is controlled by the small knob is adjusted so that the tube is oscillating properly and is not unduly critical. The condenser C1 will be the only control necessary to touch to tune in the signal. Volume is controlled at the receiver, as when using the receiver alone on higher waves. If the set employs a local-distance switch, set this control for distant reception.

The schematic diagram of the adapter in Figure 42 shows the three inductance coils, L1, L2 and L3, the radio-frequency choke coil, model No. 322, the tuning condenser C1 and the regeneration control condenser C2. The output of the converter is passed through an impedance coupling device designed for 175 kc. The leads to the cable connecting plug are also shown in this diagram.

LABORATORY-BUILT SETS

The production methods of the machine age have had to capitulate to the hand craftsmanship of older times in the construction and test of short-wave receivers designed to meet the exacting demands of modern reception. It is not sufficient that a small percentage of the total output of receivers be capable of consistent transoceanic reception. Rather it is essential that the performance of the finest model be duplicated in every receiver in the series, over a long period of usefulness. Reliability of this order exacts a high degree of mechanical and electrical perfection attainable only by the application of strictly laboratory procedure to each and every receiver.

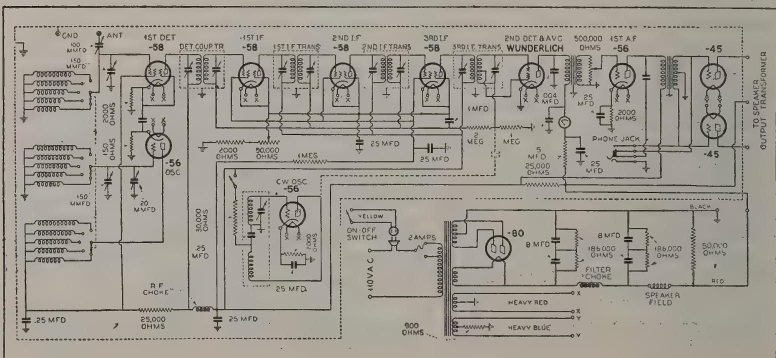
Considerations of reliability, to which no concession can be made, are further complicated by the characteristics of the higher frequencies and their circuits. Modern short-wave receivers must be

designed for beat-note as well as modulated-carrier reception. At the higher end of the spectrum, a frequency variation so slight as 0.001 percent may make all the difference between intelligibility and chaotic babel in code reception. Slight variations in inductance and capacity, negligible in even a high-grade broadcast receiver, will cause relatively great frequency shifts on the short waves, seriously affecting the performance and reliability of the commercial receiver. Engineering finesse of the highest order, accompanied with laboratory adjustments, is essential to the production of a single-control, short-wave receiver without manual compensation. Dielectric losses, inappreciable on the conventional set, assume proportions which make a receiver inoperable on waves below 50 meters unless special insulating material is employed. The possible use of the short-wave receiver for rebroadcast purposes adds still further to the problems with which the designer must contend. The automatic volume control must be unusually effective in combatting the excessive carrier fluctuation of transoceanic stations. The high amplifications employed in rebroadcasting predicates a low noise-to-signal ratio, imposing added labors in the design of a humless power supply, and suggesting the use of a minimum number of high-gain tubes and circuits. The following brief descriptions of a number of the newer and most popular multi-tube short-wave receivers will be of interest to short-wave listeners and experimenters.

THE LINCOLN R-9 RECEIVER

As a general thing, the radio enthusiast who is interested in both broadcast-band and short-wave reception has owned an all-wave receiver rather than equipment consisting of separate receivers. However, there are circumstances which may have an important bearing on this choice. It is sometimes the case, for instance, that only the man of the house is interested in what the short waves can produce, while the rest of the family demand an uninterrupted fare of broadcast programs. Even in the best-regulated families such diverse requirements are likely to cause a certain amount of friction

FIGURE 44



if both factions must depend on the same all-wave receiver for their enjoyment.

Then, too, there are some radio hobbyists and professionals who require certain features not always found in all-wave receivers. Such, for instance, as a separate beat oscillator, to permit reception of c.w. code signals, or band-spread tuning, to simplify the selection of stations in the crowded ranges of the dials. Many readers will find their own reasons for not wanting to depend on the radio in the living room for their own particular brand of radio amusement. The important factor is that there are often conditions under which a separate short-wave receiver is almost a necessity—and this need, whatever the reason behind it, is met by the new Lincoln R-9 commercial type short-wave receiver.

This new receiver, as its name implies, was designed for commercial services such as airports, news syndicates, relay work and commercial telegraph and telephone stations. In meeting the requirements of these varied services, it likewise meets every conceivable requirement of the amateur transmitting station operator and the short-wave broadcast fan. It is strictly businesslike in appearance—and businesslike in operation. There is nothing superfluous in its make-up; every part and control serves a real practical purpose. It is a laboratory-built job, designed with the one purpose of bringing in short-wave signals

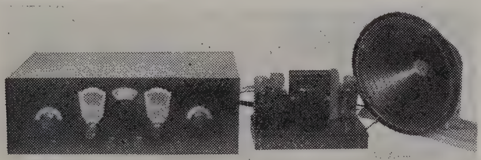


FIGURE 45

in the best possible manner, and in appearance, results and operation should suit the real DX fan or the professional user right down to the ground.

As shown in the accompanying photograph, the R-9 consists of the receiver chassis, a separate power pack which supplies all voltages for the receiver, and a heavy-duty auditorium-type dynamic speaker. The chassis employs ten of the newest tubes in a superheterodyne circuit, the diagram of which appears in Figure 44. The chassis foundation is of heavy-gauge metal, with an aluminum front panel finished in black leatherette crackle. A metal case fits overs the chassis, serving as both an overall shield and as a dust cover.

The power pack employs a type –80 rectifier and includes a heavy-duty filter which insures substantially infinite life for the filter condensers by using two condensers in series in each leg of the filter network, shunted by protective resistors. The speaker draws its field current from the power pack, its field coil serving as one of the two chokes. The adequacy of this filter is indicated by the fact that in actual operation with headphones there is no perceptible hum.

The auditorium dynamic speaker is the same type employed with the Lincoln DeLuxe All-Wave receiver, and to anyone who has heard that receiver in operation nothing more need be said. For others, it

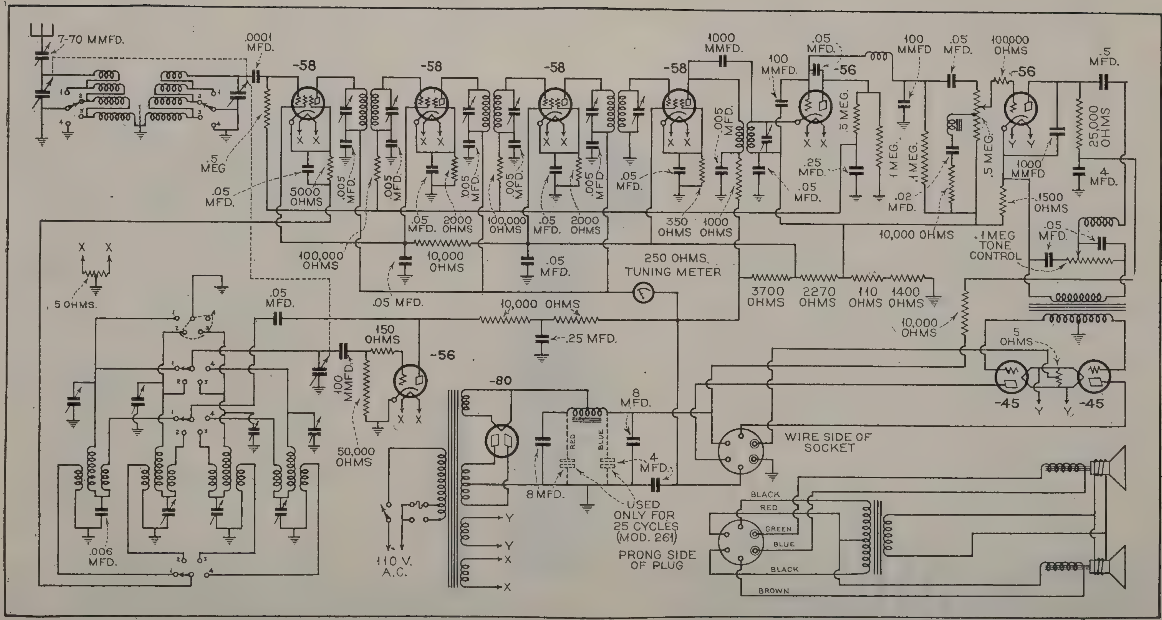


FIGURE 46

Shown above is the circuit diagram of the American Bosch Model 260 "Super". A design feature of particular interest is found in the provision for both automatic and manual tone control.

will suffice to say that this loudspeaker is one of the new high-efficiency type which someone has remarked "makes a 5-watt input sound like 10 watts." Its achievement in efficiency is only matched by its quality of reproduction.

The receiver covers from slightly over 200 meters down to a bit below 9 meters, which means that it is one of the few available receivers that cover the amateur 10-meter band as well as all the short-wave broadcast bands and higher amateur bands.

This range is covered without the use of plug-in coils. A band selector switch is provided on the front panel and permits instantaneous selection of any of the five bands which, measured during the tests, proved to be as follows: 8.8-16.8 meters, 14.6-27.7 meters, 27.4-51.6 meters, 48.2-99.0 meters and 86.2-216.0 meters. It will be noted that the individual band ranges are somewhat smaller than is usual in a short-wave receiver, which means that stations are spread further apart on the main dial and tuning is therefore made easier.

To further facilitate tuning, a band-spread condenser is provided on the panel. This band-spread arrangement takes the form of a three-plate midget condenser. Stations which fall one degree apart on the main tuning dial are spread over an average of 10 degrees on the band-spread dial. The advantage of this scheme lies in the band-spreading being effective over the entire range of the receiver. For instance, the short-wave listener, if he wants to tune around on the 49-meter broadcast band, can set the main tuning dial for a station at the lower end of this band and then do all the tuning within that band with the band-spread dial.

THE AMERICAN BOSCH MODEL 260 "SUPER"

The next receiver to be discussed briefly is the Bosch Model 260, All-Wave Super, which incorporates numerous modern refinements in broadcast receiver design and in addition includes complete coverage of the short-wave bands from 200 meters to 15 meters. A special feature of the design is found in the directly tuned antenna circuit, not alone on the broadcast band, but throughout the entire range of the receiver. In the days of one and two-tube receivers, the advantage of a tuned antenna was appreciated, but in later years, with the development of multi-tube sets, the tendency has been toward a certain amount of sacrifice in efficiency, to be compensated for by the addition of more tubes. The designers of the receiver under discussion have evidently sought for high efficiency, in addition to the use of 10 tubes of the most modern types.

The tuned antenna system offers a two-fold advantage. First, and most obvious, is the increased signal pick-up and more efficient transfer of the signal to the tube circuits. Less obvious, but equally important is the improved signal-to-noise ratio which results. This noise reduction has two explanations. In the first place, a tuned antenna provides a higher signal input to the receiver than does an untuned antenna circuit, yet external noise is approximately the same for both. The signal-to-external noise voltage ratio is therefore directly improved. Secondly, with tube noise (the most important of which originates in the first tube) more or less constant for all signals, the higher the signal placed on the grid of the first tube, the lower the tube noise will be in proportion.

Antenna tuning is, of course, rather broad and, unless precautions are taken, will result in a reduction of adjacent channel selectivity. One such precaution may be found in providing relatively loose coupling between the antenna and first tube. This retains the advantage of external noise reduction, but loses the advantage of reduced tube noise ratio. Another means is to provide high selectivity in the intermediate-frequency amplifier. In the Model 260 it will be noted that, including the oscillator, there are 8 tuned circuits between the first and second detectors—adequate to provide a high degree of i.f. selectivity.

Manufacturer's Model: American Bosch Model 260, superheterodyne.

Tuning Range: 15 meters-555 meters, divided into four bands as follows: 15-35 meters, 33-85 meters, 79-200 meters and 200-555 meters.

Tubes: 3 type –56, 4 type –58, 2 type –45 and 1 type –80.

Power Source: 110-120 a.c., 25-60 cycles.

Loudspeaker Equipment: Dual type dynamics.

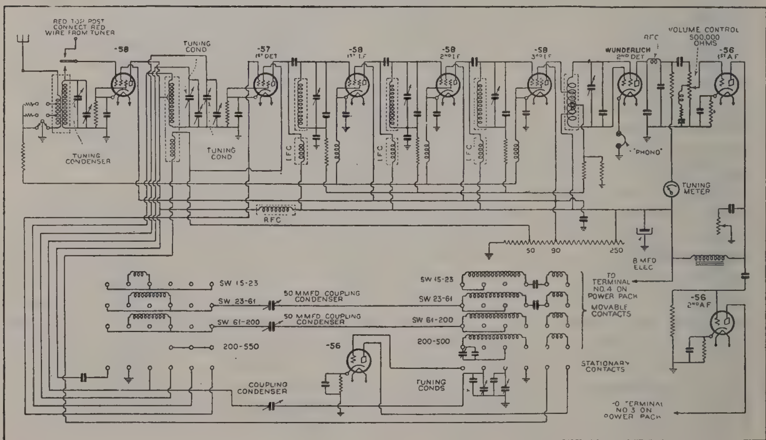
Manual Controls: Four front-panel controls which include band selector switch, station selector dial, volume control (with on-off switch integral) and tone control.

Features: Automatic volume control, meter tuning, manual noise suppressor to eliminate noise between stations while tuning, antenna balancing control at rear of chassis to adapt receiver to antennas of different size.

THE SCOTT DELUXE ALL-WAVE SUPER

The true single-control tuning of the Scott DeLuxe All-Wave Superheterodyne has proven to be all that was claimed for it. It is no great trick to provide a single control for a *broadcast* superheterodyne, but to extend single-control operation, with no auxiliary verniers of any type, *throughout the entire wave-band from 550 meters down to*

FIGURE 47



15 meters, is a real accomplishment. That it has been accomplished effectively in this receiver is quite evident from the sensitivity and selectivity demonstrated on all wave-bands. The success of this system is due to a feature of the electrical design of the receiver which makes tracking of the circuits mostly automatic. It would be impossible to apply the ordinary methods of ganging over such a wide frequency band, but by combining these methods with special coupling design, the seemingly impossible has been accomplished.

In the broadcast band there are three tuned circuits—the r.f. tube input, the first detector input and the oscillator. When the band switch is thrown for any of the three short-wave bands, the tuned input circuit of the r.f. tube is automatically taken out of the circuit and, instead, the primary of the broadcast antenna coupler is connected directly into the grid circuit of this tube. The result is that for short waves the antenna is conductively coupled to the r.f. tube and, by means of the local-distance tap switch, even this circuit is partially tuned. The first detector input and the oscillator circuits are both tuned when operating on the short-wave bands, the same as on the broadcast waves.

The band-switching system has proven itself flawless in operation. A simple throw of this switch to any one of its four positions selects the desired wave-band. An interesting illustration of the simplicity of this arrangement is found in tuning from W8XK, the Pittsburgh short-wave station that operates on 48.86 meters, to WEAF. It so happens that W8XK comes in at exactly the same point on the dial

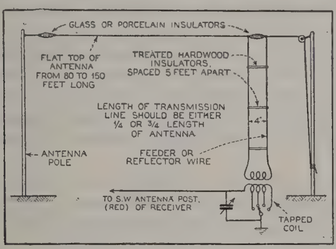


FIGURE 48

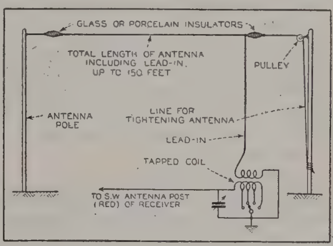


FIGURE 49

as does WEAF. Thus with the band switch set for the 23-61 meter band and with W8XK tuned in, a turn of the band selector switch to the broadcast range is all that is necessary to bring in WEAF.

Another interesting point disclosed in tests was the accuracy of the frequency calibration on the broadcast band from 550 kc. to approximately 1000 kc. Every channel below 1000 kc. may be tuned in right on the dot as indicated by the frequency scale. From 1000 kc. up, the calibration is slightly off, but the maximum variation is less than one channel (10 kc.). The advantage of this degree of accuracy is seen when a station is tuned in and one can tell at a glance the frequency upon which it is operated. For the DX enthusiast this feature is invaluable. Even to those who are not particularly interested in DX reception, it is most decidedly an advantage to be able to set the receiver for the frequency of any desired station with the assurance that that station will be heard.

The two most obvious improvements over earlier models are the inclusion of the highly effective automatic volume-control system and a unique tuning-meter arrangement.

The tuning meter is an improvement which offers a decided operating advantage. Its method of application in this receiver is of particular interest. The meter itself is not visible but is completely

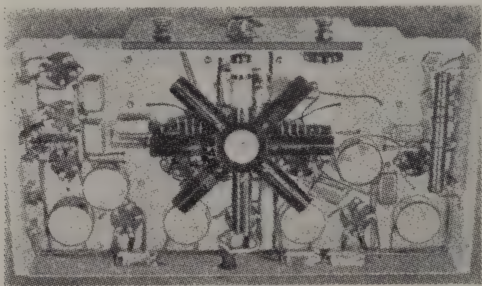


FIGURE 50

concealed behind the front panel. Only the image of its needle is visible. This image is projected on the calibrated tuning scale and is therefore always directly in the field of vision while tuning the receiver, making it unnecessary to move the eyes back and forth from the tuning scale to the tuning meter while operating the receiver. This tuning meter is included in the plate circuit of the second detector and gives a direct indication of the r.f. signal strength. It does not fluctuate with modulation nor is it in any way affected by the adjustment of the manual volume control. It has a wide range of deflection with a readily evident movement even on extremely weak signal inputs.

The improved electrical characteristics of the receiver are accounted for primarily in the use of the latest types of tubes in all but the power output stage, where push-pull –45's are still employed, and the power supply, which employs an –80 type rectifier. The other nine tubes are three type –56, one type –57, four type –58 and a Wunderlich tube for the second detector and automatic volume control. The positions in which these tubes are used are shown in the circuit diagram, Figure 47.

Starting at the input, the other improvements and refinements which have been made will be taken up.

The first is the provision for use of a tuned transmission type antenna lead for short-wave reception shown in Figure 48. The manufacturer has found such an antenna system to offer considerable advantage over the ordinary "L" type antenna for the short waves. The effect of tuning the antenna is to greatly increase signal strength on weak short-wave stations, while the use of a parallel lead-in tends to confine signal pick-up to the antenna wire proper, thus reducing certain types of interference. A complete antenna with two-wire parallel lead is shipped with every receiver, and also an antenna tuning unit. This unit consists of an antenna-coupling transformer,

tapped for the different wave-bands, a variable condenser and an inductance switch, all amounted on a metal plate. Binding posts are included for connecting the two lead-in wires, and two wire terminals provide the connections to the short-wave input of the receiver. A regular untuned antenna of the "L" type is recommended for broadcast reception, and the transfer from this to the short-wave antenna system is accomplished automatically by means of the switch shown in the grid circuit of the r.f. tube (Figure 47) which is a part of the main band-selector switch.

The use of the special short-wave antenna and tuning unit is not essential and is provided for those who desire to obtain maximum results on the short-wave bands. By connecting a wire between the short-wave and broadcast antenna binding posts at the rear of the chassis, short waves can be received on the ordinary broadcast antenna in the same manner as the broadcast stations.

On the whole, this receiver seems to be one which will meet the demands of every type of radio listener. Its operation is so simple that even a novice will not have the least difficulty in using it. On the other band, its performance is such as to satisfy the requirements of the most rabid DX fan, and not the least of advantages is the fact that maximum performance is easily obtained, even by one who knows nothing about the technical side of radio.

THE HAMMARLUND COMET "PRO"

The new Hammarlund Comet "Pro" all-wave receiver uses the same chassis size and general layout as its earlier models. Like the original model, the new one employs eight tubes, including the rectifier, but an important advance is shown in the use of the newest tubes throughout. Instead of the –24's, –35's and –27's used before, –57's –58's and a –47 are now employed. This feature alone represents a considerable improvement in sensitivity, and the new tubes used in the r.f. and intermediate-frequency circuits provide absolute stability in operation.

The most noticeable physical change has been in the adoption of a metal cabinet. This cabinet is crackle-finished to match the appearance of the metal front panel and is liberally ventilated by means of louvres. The wood cabinet, like that in which the early model was housed, is available for those who prefer it, but the metal cabinet offers the advantage of additional overall shielding which under some conditions will be found advantageous.

Looking at the chassis itself, the first change to strike the eye is the provision of shield cans over the two plug-in coils. This change is a radical one, because while dependence was placed on the inductive relationship between the oscillator and r.f. plug-in coils to provide the oscillator coupling in the earlier model, inductive coupling between these coils is purposely avoided in the new model. The high-frequency oscillator is now electron-coupled to the first detector circuit, and complete isolation of the two circuits, so far as extraneous coupling of any kind is concerned, is therefore necessary if full advantage is to be taken of the best features of electron coupling. More will be said
The shielding of these coils provides another outstanding advantage
of this coupling system later.
in that direct pick-up of either signals or strays is eliminated.

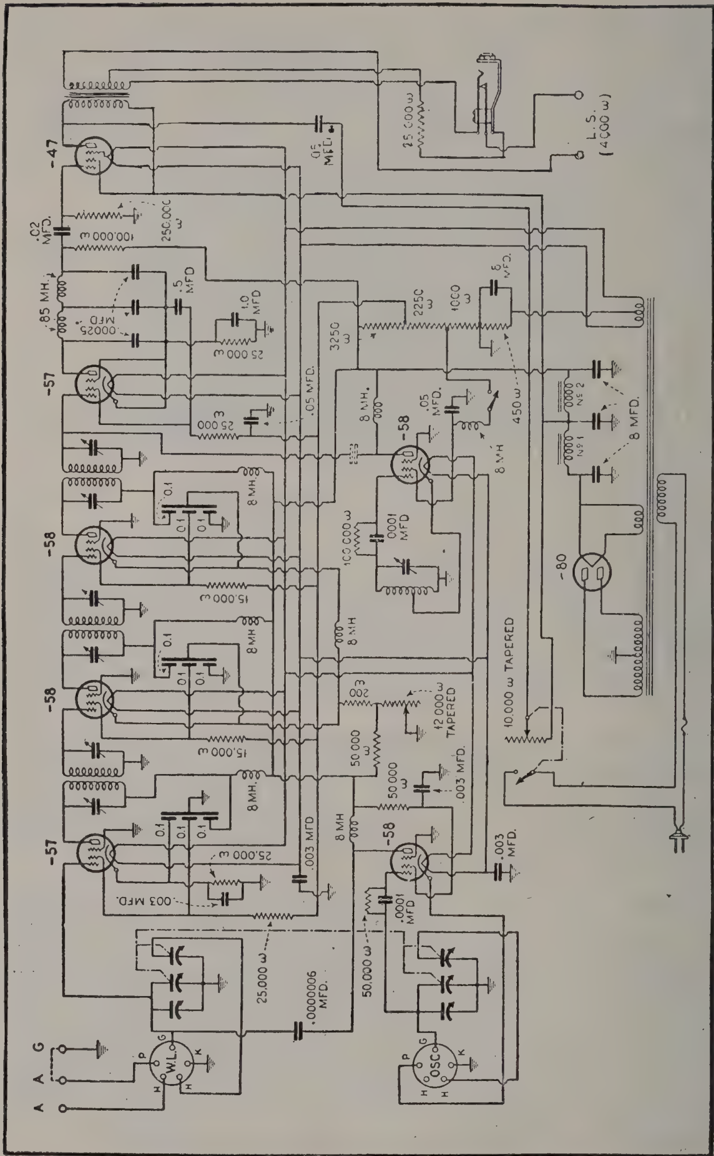

A
A
G
W.L.
OSC
-57
-58
-58
-57
-47
-58
-58
-80
.02 MFD.
.85 MH.
.00025 MFD
.5 MFD
1.0 MFD
.05 MFD.
.003 MFD
.003 MFD.
.0000006 MFD.
.0001 MFD
8 MFD.
L.S. (4000 ω)
10,000 ω TAPERED
12,000 ω TAPERED

FIGURE 51

Anyone familiar with short-wave work will realize that on wavelengths around 50 meters and lower, the direct pick-up provided by a single unshielded coil is adequate under certain conditions to make audible the signals from stations a thousand miles away or more. Also the lack of proper shielding permits the direct pick-up of stray interference, whereas, with pick-up limited to the antenna proper, such interference may be largely attenuated by the relatively loose coupling provided in the antenna coil, and the signal input is more directly under the control of the operator.

Skipping now to the ouput of the new receiver, another and rather extensive revision is found. In the earlier model a type –27 tube was employed in the audio output stage, providing a limited amount of audio-frequency gain and relatively low power-handling ability. It was suitable for headphone output and for moderate loudspeaker volume, but where greater volume was required it was necessary to resort to the use of an external power stage.

In substituting a type –47 tube for the old –27, both gain and power-handling ability have been greatly increased, with the result that plenty of volume and power are provided for good loudspeaker operation without resorting to the use of additional amplifier equipment. But for headphones—and many operators and "hams" demand headphones—the output of a –47 tube is too great to be practical. An output transformer was added, and tapped to provide a considerable step-down in signal voltage to the headphones. This not only has the effect of reducing headphone volume, but the transformer eliminates direct current from the 'phones and speaker windings. This is, of course, essential when a plate current of the magnitude of that required by a –47 tube is present.

To further improve headphone reception, a 25,000-ohm resistor is inserted in series with the headphone jack. The signal output divides between this resistor and the headphones in proportion to their

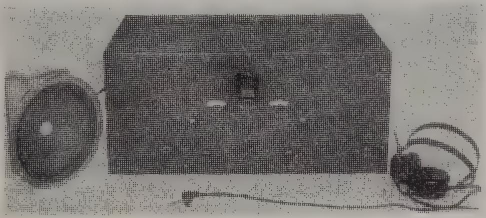
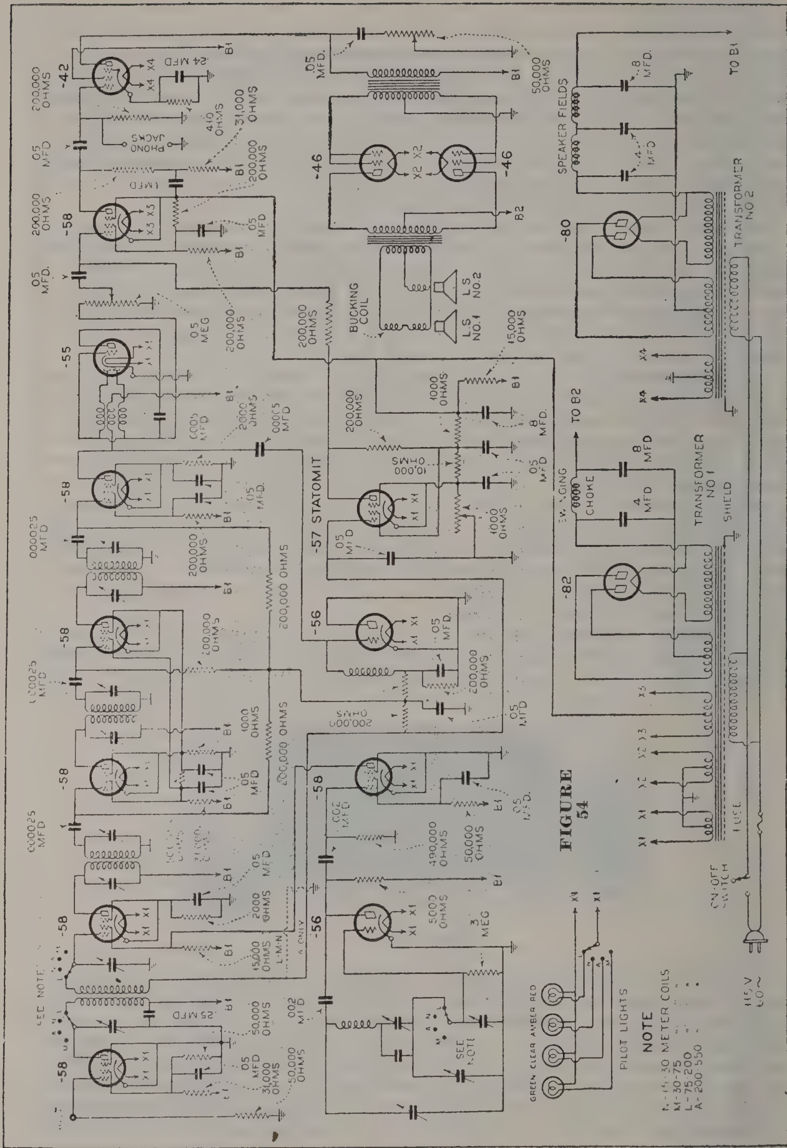


FIGURE 52

impedance. At the lower audio frequencies the average headphone has an impedance of a low order, therefore most of the signal voltage is spent along the 25,000-ohm resistor, only a portion of it being impressed on the 'phones. As the audio frequency increases, however, the headphone impedance rises and a proportionately larger part of the signal voltage is impressed across the 'phones. The overall result is that the low frequencies, which are of relatively small importance in headphone reception, particularly c.w. reception, are considerably attenuated, along with low-frequency noise. The higher frequency


-42
-58
-55
-57 STATOMIT
-56
-46
-80
-82
200,000 OHMS
.05 MFD.
.24 MFD
PHONO JACKS
410 OHMS
31,000 OHMS
1 MFD
.05 MEG
50,000 OHMS
.000025 MFD
200,000 OHMS
.0005 MFD
2000 OHMS
10,000 OHMS
1000 OHMS
15,000 OHMS
8 MFD.
4 MFD
.25 MFD
.002 MFD
490,000 OHMS
5000 OHMS
3 MEG
SEE NOTE
BUCKING COIL
L S NO.1
L S NO.2
SPEAKER FIELDS
TRANSFORMER NO 2
TRANSFORMER NO 1
SHIELD
CHOKE
TO B2
TO B1
FUSE
ON-OFF SWITCH
115 V 60~
GREEN CLEAR AMBER RED
PILOT LIGHTS
NOTE
M-30-75
L-75-200
A-200-550
FIGURE 54

signals, on the other hand, are increasingly strong, thus accentuating the portion of the audio range which includes the voice and c.w. frequencies. One of the important changes in the improved model is found in the use of type –58 tubes for both the r.f. and heterodyne beat oscillators. Not just the fact that new tubes are used, but what is more important—the adoption of electron coupling. Electron-coupled oscillators have proven their outstanding utility in frequency-changing circuits of superheterodyne receivers. Their special advantage lies in their stability of oscillation at all of the usual short-wave and broadcast frequencies. Many other types of oscillators drop off materially at radio frequencies approaching 20,000 kc. (15 meters), but the oscillator circuit as employed in the receiver under discussion here functions uniformly and strongly throughout the entire range of this receiver. The intermediate amplifier is the same as employed

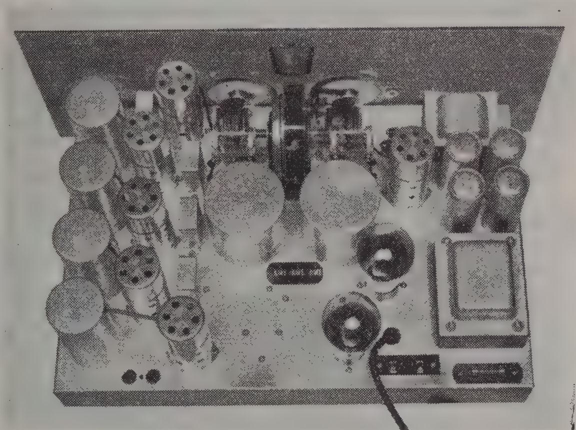


FIGURE 53

before, except that in the improved receiver tubes of the –58 type are used in the two i.f. stages. Double-tuned coupling circuits are employed, and this amplifier operates at 465 kc. as before. Sensitivity control is obtained through a 12,000-ohm tapered rheostat in the cathode circuits of these two tubes.

Another new feature of great importance is the provision for use of a transmission-line type of antenna lead-in. Such a lead-in is effective only when the two sides of the lead-in are balanced, and such a balance cannot be obtained if one end of the antenna coil is grounded. Heretofore all receivers have had one end of the antenna coil grounded, with the result that, effectively to use a lead-in system of this type, it has been necessary to first perform a minor operation on the receiver itself, isolating this coil from the chassis and ground. In the "Pro" the two ends of the antenna coil terminate in two antenna connection posts, both insulated from the chassis and other parts of the circuit. A third post provides for grounding the chassis.

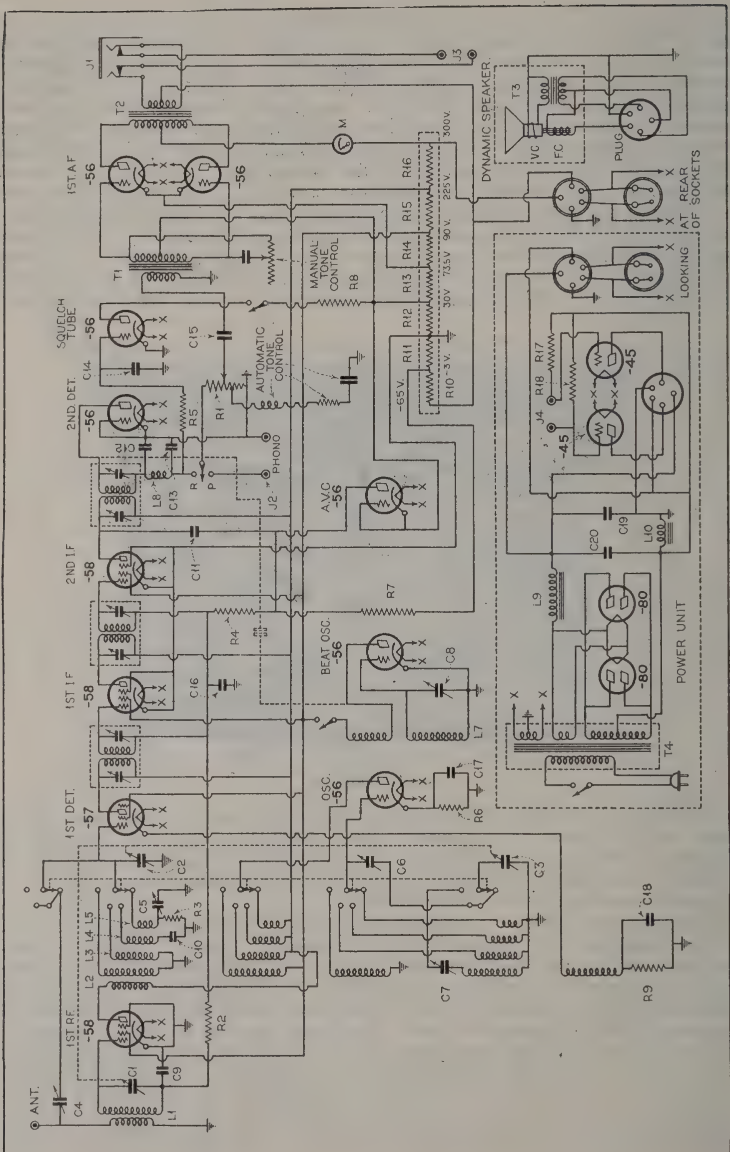

ANT.
C4
L1
C1
C9
1ST RF.
-58
L2
R2
L3
L4
L5
C5
R3
C10
C2
1ST DET.
-57
OSC.
-56
C6
C3
C7
C17
R6
R9
C18
1ST I F
-58
C16
L7
C8
BEAT OSC.
-56
R4
R7
2ND I.F
-58
C11
A.V.C
-56
J2
PHONO
R
P
L8
C13
C12
2ND. DET.
-56
R5
R1
C14
SQUELCH TUBE
-56
C15
AUTOMATIC TONE CONTROL
MANUAL TONE CONTROL
R8
T1
1ST. A F
-56
-56
T2
J1
J3
M
R10-3V.
R11
R12
R13
R14
R15
R16
-65 V.
30V
73.5V
90 V.
225 V.
300V.
DYNAMIC SPEAKER
T3
VC
FC
PLUG
AT REAR OF SOCKETS
LOOKING
R17
R18
J4
-45
-45
C19
C20
L10
L9
-80
-80
POWER UNIT
T4

FIGURE 56

THE MIDWEST SIXTEEN-TUBE SUPER

The Midwest low-cost all-wave superheterodyne receiver employs 16 tubes, with automatic switching, automatic volume control, between-station noise suppression and many other features as can be

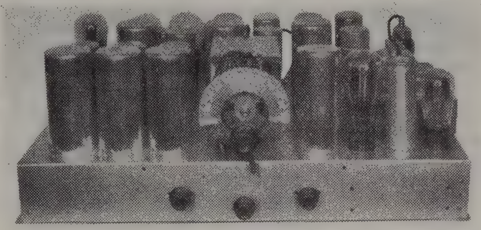


FIGURE 55

seen from the wiring diagram in Figure 54. It is completely shielded and covers the whole wavelength range from 15 to 550 meters. An exceptionally efficient receiver for such a low price range.

THE "MASTERPIECE" FIFTEEN-TUBE RECEIVER

The Silver "Masterpiece" receiver uses only one accurately calibrated tuning dial to tune from 13 to 570 meters, and consists of three units—tuner, power amplifier and power supply, and giant super-efficient dynamic speaker. The tuner chassis is 19 inches long, 10½ inches deep and 8¾ inches high. The amplifier is the same length, 5 inches deep and 7½ inches high, while the giant speaker is 13¾ inches high, 8 inches deep, weighs 42 pounds and has a 12-inch cone and 2½-inch voice coil. All units are finished in buffed and

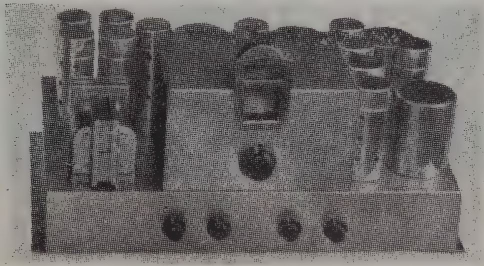


FIGURE 57

lacquered brass, with the tube and i.f. transformer shields of the tuner of polished aluminum.

The receiver employs a total of fifteen tubes, which are seven –56's, one –57, three –58's two –45's and two –80's.

The circuit is essentially a standard superheterodyne. It consists of a –58 tuned r.f. stage, –57 extra sensitive tuned first detector, –56

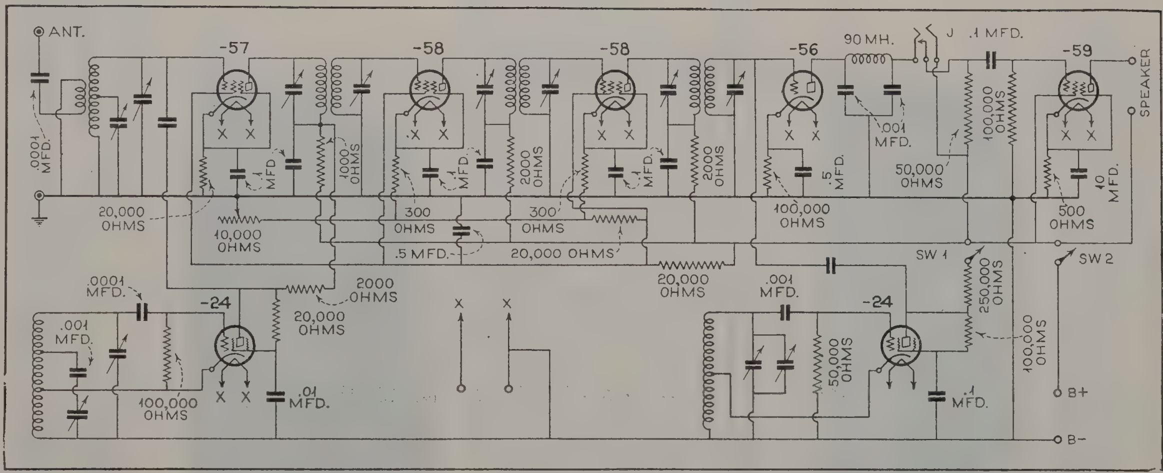


FIGURE 59

Above is shown the circuit diagram of the seven-tube National FB-7 receiver. It is a superheterodyne with an electron-coupled beat-frequency oscillator which helps materially in tuning in distant foreign stations. Exclusive features include: Front-of-panel coil-change, Class A power-pentode output, "True-tracking" single control tuning, and calibrated volume-control.

tuned oscillator, two –58 stages of dual-tuned 465 kc. intermediate-frequency amplification, a –56 used as a diode second or power detector, –56 a.v.c. tube, –56 squelch circuit or automatic noise suppressor, –56 audio beat oscillator for c.w. code reception, two –56's in a Class A Prime push-pull first audio stage, two –45's in a push-pull Class A Prime output stage, and two –80 rectifiers in parallel to supply the power for the set and speaker field. The controls of the set are five in number, being, left to right: volume control, manual tone control, single tuning knob and calibrated dial for all wavelengths, "squelch" cut-out switch and audio beat-note oscillator switch. In addition, automatic tone compensation is provided to raise bass and treble notes at low volume to take care of variations in the sensitivity of the human ear at different volume levels. The manual tone control is provided to allow for different musical tastes, and for such noise reduction as may be desired on weak signals falling below the cut-off level of the squelch circuit.

THE NATIONAL FB-7 RECEIVER

This compact but very sensitive superheterodyne short-wave receiver is a seven-tube short-wave superheterodyne utilizing five sets of plug-in coils. It was originally designed for use by the discriminating amateur, who required the latest modern design for short-wave work, including all the amateur bands of reception. As will be seen from the photograph in Figure 58, the plug-in coils set into the face of the panel, which makes wave-changing an instantaneous and almost automatic action. All that has to be done is to place the forefingers of

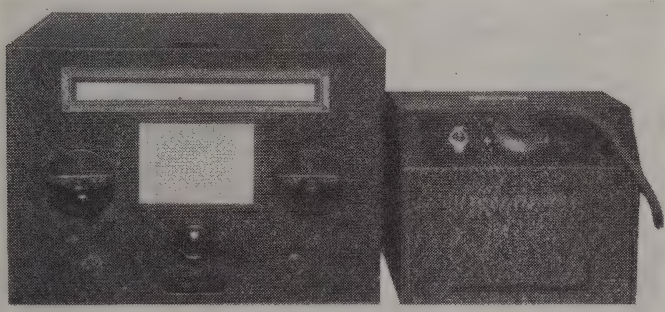


FIGURE 58

the two hands in the rings in the coil ends, pull them out, grasp the two new coils in the same manner and plug them in. No shields have to be removed. Each coil is lettered A to E inclusive; they come in sets of two and one is marked "Osc" and the other is marked "Det." Looking at the panel, the left-hand coil is the oscillator coil.

These coils have a complete range from approximately 15 to 200 meters. The actual range of each coil is as follows: Coil A from 15 to 26 meters. This is the range taking in the 20-meter

amateur band as well as the 16, 19 and 25-meter short-wave broadcast bands. Coil B runs from 25 to 43 meters, including the 40-meter amateur band, the upper part of the 25-meter broadcast band as well as the complete 31-meter broadcast band. When using the 25-meter broadcast band, it is sometimes advisable to change coils to see which produces the loudest results. Coil C runs from 41 meters to 72 meters, including the 48-meter broadcast band and a number of amateur 'phone stations as well as aircraft stations. Coil D runs from 70 meters to 125 meters, taking in the 80-meter band as well as the police bands, including special amateur telephone stations, many broadcast station harmonics, etc. Coil E covers the band running from 120 meters to approximately 200 meters, although the highest wavelength broadcast station we actually received on it was WHOM at 1450 kilocycles. This came in at about 5 on the dial.

The circuit diagram for this receiver accompanies. the text It will be noticed that the detector tube is of the type –57, with a type –24 tube as oscillator in a very stable circuit. Two type –58 tubes serve as intermediate-frequency amplifiers, with the grid and plate circuits tuned by the latest type air-dielectric condensers. The second detector is a type –56 tube employing a plate-filter circuit and resistance-coupled to a type –59 pentode output tube. A jack in the output circuit of the second detector automatically disconnects the pentode tube and speaker. A type –24 tube is used as a beat-frequency oscillator for reception of c.w. signals.

CHAPTER 6

Getting the Most Out of the Short Waves

ALTHOUGH short-wave radio has made great strides recently, there is still much to be learned about it. Today, there is one group of radio men who are telling the world not to expect much from short waves while another group is telling all about the wonders of reception to be had on a short-wave receiver. Between the two groups, Mr. and Mrs. John Public hardly know what to believe. These two groups are made up of people whose experiences with short-wave reception has been either good or bad, according to which group they are in.

The degree of success obtained by a listener on short waves depends on four things; namely, the receiver used, the accessories, the location

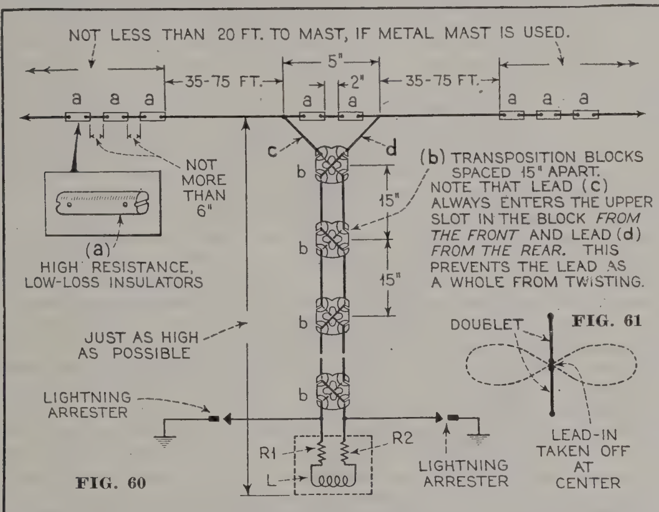


FIG. 60

FIG. 61

and the skill of the operator. By accessories we mean such things as the antenna and ground system and the quality of the tubes used. These things are far more important on short waves than on long waves and they must be given good attention.

Taking these things in order, we first come to the receiver. Here we find a consideration that has given short waves more "black eyes" than any other thing. If you are accustomed to hearing local broadcast stations on an eight or ten-tube receiver that has enough volume to fill your home with good music and entertainment, you will hardly be satisfied to go back to the old-style one and two-tube receivers, would you? The volume, clarity and tone would be missing. A few years back, there was nothing but one and two-tube sets for the short-

wave listener, and people who bought them usually were not satisfied. But today things are different, since the modern short-wave set is the equal of a long-wave receiver. There are still a number of small sets sold, and they have their place in the short-wave field. But no one can expect a one or two-tube set to bring in stations ten thousand miles away with the volume and clarity equal to a ten-tube broadcast set, just because it happens to be a short-wave receiver. But thousands of people have bought or built these little sets and expect such results. True enough, it is possible to get many distant stations on a small set, and ofttimes a small set in the hands of a skilled operator will perform better than a large set in the hands of an unskilled operator, when it comes to getting the most stations. But certainly no little set can equal a modern high-powered, multi-tube receiver for quality of tone, volume and consistency. If you like to experiment and listen with headphones for distant stations, the small set may be satisfactory, of course, but if you do buy one, remember that you can only expect lesser results. And if you are not satisfied, don't blame it on the short waves. A Rolls-Royce engine does not come in a "flivver."

Another thing to remember when buying a short-wave receiver is that some of the multi-tube sets are manufactured on a production basis. Some sets do not cover the short-wave field completely, yet they are advertised as "all-wave" sets. Some, we have seen, go down to only about 150 meters and others down to only 75 meters. No real distant broadcasting stations are heard above 75 meters. International broadcasting takes place below that wavelength. On such receivers, only police stations, aircraft, beacons, code and amateurs are heard. In other words, some of these sets are just half short-wave sets. If the receiver you have in mind does not go down to at least 15 meters, you are going to miss a lot of the pleasure of owning a short-wave or all-wave receiver as the case may be.

Adapters and converters are confusing to nearly all newcomers in short waves. There is a world of difference between them. An adapter simply uses the detector tube of the receiver and the audio stages, picking up the signal like a regenerative receiver and sending it through the audio stages. Since the modern radio receiver goes in for more radio-frequency amplification and less audio amplification, the signal from the adapter is usually too weak to be heard well, simply because there is not enough radio-frequency amplification to build the signal up to loudspeaker strength. A converter is a different proposition. It takes the signal as it comes from the antenna and changes it into electrical impulse of constant frequency which is sent through all the tubes in the receiver. The way to tell the difference between an adapter and a converter is to find whether you have to take the detector tube out of your receiver to install it. The converter works with the regular receiver, on the antenna and ground and using the set's r.f. amplifier, while the adapter takes the detector tube out of the regular receiver and uses it to detect the signal in the adapter.

When a set is installed, all tubes should be thoroughly tested. We say this because ofttimes a tube will work well enough on powerful signals, but may not be able to amplify or detect a weak one. Have every tube tested, no matter if they are new! The detector tube in

a short-wave set is very important. Change the tubes about in the set till you find one that works best in the detector socket. Do this by tuning in a fair signal and note the volume as each different tube is inserted. If the set has a tendency to howl, tap the detector tube with your finger and see if it sets up a bell-like howl. If so, replace it.

Now for the antenna. Many aerials that work well on long waves are not suitable for the short waves. The average radio receiver today has enough radio-frequency amplification to pick up signals on a short piece of wire used as an antenna. But the actual amount of energy picked up from a station ten thousand miles away is only a fraction of that picked up from a local station, and every bit of it must be conserved and passed on to the receiver if the station is to be

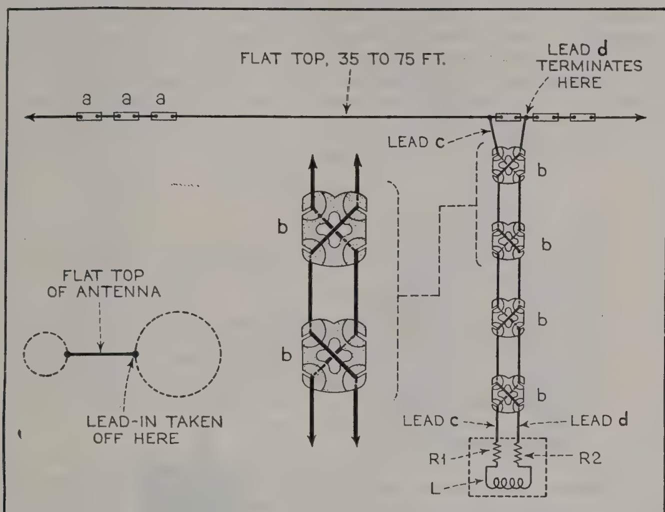


FIGURE 62—RIGHT. **FIGURE 63—LEFT.**

heard satisfactorily. An aerial used for short-wave reception must be well insulated, free from moving objects, and the lead-in wire, especially, must be stout and well insulated. Don't be afraid to use insulators and many of them. The lead-in should not run all over the house or the room before it reaches the receiver. Run it to the window nearest the set and then as direct as possible to the set.

Those who are experienced in short-wave reception have come to appreciate the fact that the short waves have outstanding advantages. So far as DX work is concerned, for instance, reception from all parts of the world is practically an every-day occurrence with any really good short-wave receiver. Also static is less troublesome in these lower ranges. As against these advantages there is one factor which becomes much more important on the short waves than on the

broadcast band, and that is found in the greater susceptibility to certain types of noise, and particularly to man-made interference.

In introducing this discussion it is well to call attention to certain thoughts concerning antenna equipment. The ideal antenna is, of course, one which will pick up maximum signal voltage with a minimum of noise and interference. Both the lead-in and the antenna proper require special consideration and treatment if best results are to be obtained. The lead-in serves its purpose best when it is simply a transmission line and is so designed that it is incapable of picking up electrical impulses of any kind. The collection of radio energy should be the function of the antenna proper.

Inasmuch as a great deal of the interfering noise of the "man-made" variety has its point of origin close to the ground, it is desirable to have the entire collector system well up in the air, dispensing with the ground entirely. Thus the doublet type of antenna is one of the recommended types, when connected as shown in Figure 60. The two wires of this arrangement provide the two sides of the collector system, and the whole is therefore much less likely to pick up noise from sources on or near the ground and with limited fields. The conventional L type antenna with a single-wire lead-in and ground

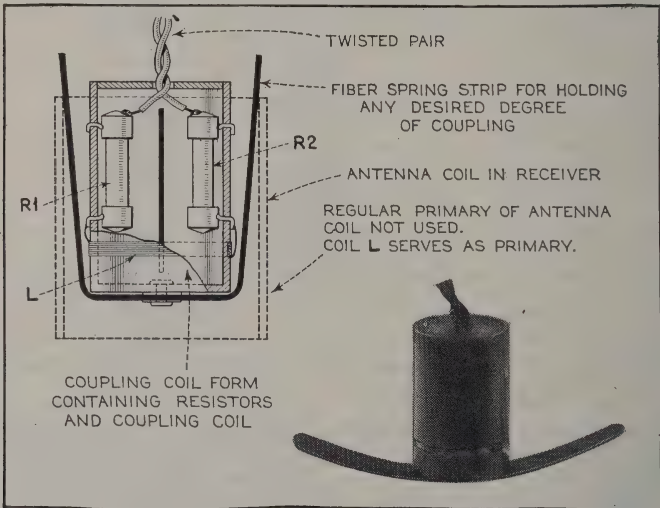


FIGURE 64

connection, on the other hand, has the overhead wire and the ground as the two sides of the collector system. Noises arising in the house, on the roof of which the antenna is erected, therefore constitute the filling for what we might call "an ethereal sandwich." Being directly within the field of the antenna, they are picked up with considerable strength. In addition to this, the single-wire lead-in constitutes part of the collector system and, as it runs directly into the house, natu-

rally tends to pick up noises from the house wiring system, telephones and the like.

Reasoning along these lines, the logic of dispensing with the ground as a part of the antenna system is quite apparent. Also the need for avoiding pick-up by the lead-in is equally obvious. Actually, of course, a two-wire lead-in, whether it be of the parallel or of the transposed varieties, does pick up both signal and interference, but the two wires pick these voltages up 180 degrees out of phase. The

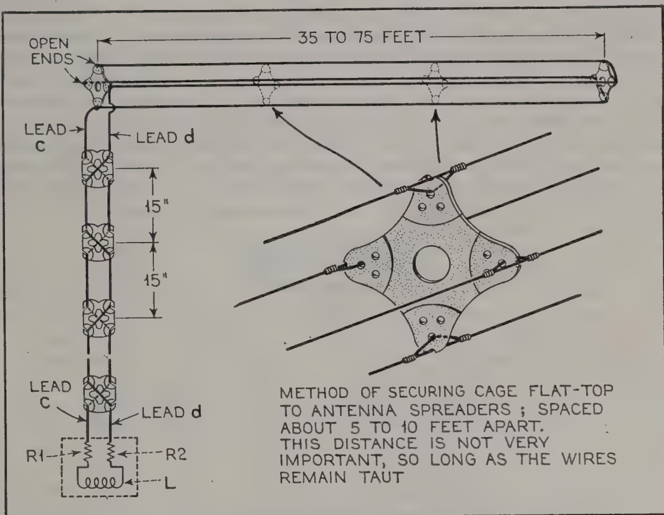


FIGURE 65

pick-up from both is impressed across the coupling coil at the receiver, where they partially cancel out, leaving the voltages picked up by the antenna proper to be transferred to the receiver circuits. The advantage of the transposed lead lies in the tendency of local interference to be picked up with equal intensity by the two wires so that the amount of voltage impressed on the coupling coil from each wire will be more nearly equal than would be the case if the two wires were parallel and one was closer to the source of interference than the other. Thus the transposed lead results in more complete cancellation.

These methods of antenna improvement do not constitute a cure-all for noise, and it is well to point out this fact lest readers be misled. Powerful interference noise which has its source some distance from the antenna system will naturally be picked up by the antenna proper just as will the desired signal. But the systems described in this article will in most cases result in material improvement in signal-to-noise ratio, because much of the troublesome noise either has its source within the immediate vicinity of the receiver location or is brought into this vicinity by the electric light or telephone lines and

should therefore be greatly attenuated by the systems discussed here.

A study of the various types of antennas which can be erected in congested areas, with the least expense and with the best possible results for the particular service required, leads us to the selection of one of three fundamental types, with possible variations to suit special requirements. Where the space permits, the use of the horizontal doublet, with a transposed transmission line lead, is just about the ideal type.

As shown in Figure 60, this antenna is made of two single wires of equal length, run in a straight line, or 180 degrees apart, separated from each other by suitable insulators and as thoroughly isolated from all surrounding objects as possible. The dimensions and the general instructions for the erection of an antenna of this type are given in the drawing. It is best to figure on permitting the antenna to come no nearer than twenty feet from the roof, or any grounded object over which it must pass, such as barns, trees, tin roofs, etc. If moving the antenna to one side or the other a slight amount will

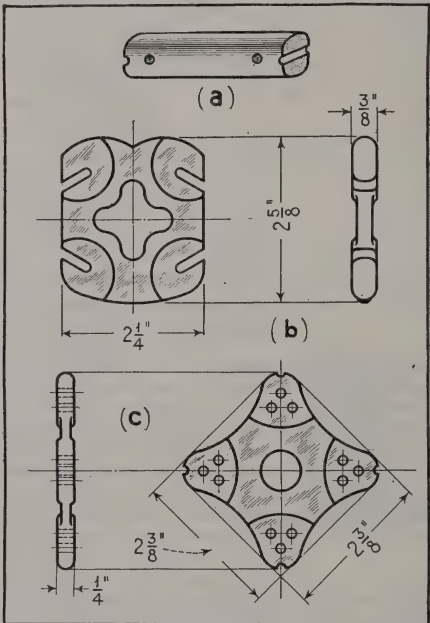


FIGURE 66

avoid the necessity of having it pass over some object, it is desirable to do so even though this may result in increased length of the lead-in. The doublet will be so much better than the ordinary type of antenna that you will never notice the very slight loss which the increased lead-in length will produce.

The directional properties of such a system have confused a number of old-timers who have it fairly well rooted in their minds that an inverted L antenna will receive best in the direction opposite the free end. They cannot understand, if that is true, why the use of the doublet should bring in signals best in the direction at right angles to the flatter portion of the antenna. However, with a doublet of this variety, whether it be of the tuned or untuned variety, reception will be best in the plane 90 degrees off the direction of the doublet. In other words, if you want to receive stations in Australia and in Europe, consulting a mercatorial map or looking at a globe will indicate that the direction from almost any portion of the United States will put Australia to the southwest and Europe to the northeast. Reference to Figure 61, showing the directional properties of the doublet, suggests that the best direction for the running of the antenna is therefore, southeast and northwest, or at right angles to a line drawn on a globe from Australia to Europe.

The inverted L type antenna is probably the easiest to erect, but the modern version is provided with a suitable transposed transmission line lead, as shown in Figure 62. The lead is taken from the end of the flap-top from which we wish to receive. For instance, if we wish to receive from Europe, our flat-top should preferably run in a general northeast and southwesterly direction, with the transposed transmission line lead, taken from the northeasterly end. This is not imperative, however, as its directional properties are not marked.

As shown in Figure 62, the top end of the second wire (d) in the transmission line lead goes nowhere. That is, it goes nowhere electrically. Physically it is terminated at the opposite end of the insulator to which the terminal for the lead-in end of the flat-top is attached. It is but natural that the question of an unbalanced system, with a rather long flat-top and its down lead on the one hand, is opposed by nothing but the down lead itself on the other. The system is partially unbalanced, but the greater part of the effect of this unsymmetrical condition is reduced by the simple process of placing a suitable resistance (R1, 2) in each of the base positions of the two wires which go to make up transmission line lead-in, as shown in Figures 60 and 62. In this connection it will be found that the value of the resistances for optimum results at given frequencies will vary. It is a simple matter to incorporate a suitable resistor mount in each lead and make the necessary changes by having a supply of fixed resistors on hand, offering a range of resistance from two hundred to about one thousand ohms. But in many instances it will be found that there will be plenty of signal, especially if the length and the height of the flat-top portion of the antenna system is great, so that adjustment of the resistance in series with the coupling coil is unnecessary. This is particularly true when it is possible to adjust the coupling between the transposed lead-in and the tuned circuit of the receiver to which it is coupled. In such cases the value of the resistors, for best average results, is in the neighborhood of 400 ohms each. A very simple means for coupling a transposed lead to any sort of receiver, other than those in which the antenna coil is completely enclosed within a shielded can, is shown in Figure 64.

To operate a completely shielded type of receiver in conjunction with a transposed transmission-line type of lead, regardless of the

character of the flat-top, it is but necessary to locate the primary of the antenna coupling transformer. This is generally a very simple matter, because one end of the primary is connected to the binding post marked ANT. The opposite end of the coil is either grounded directly to the chassis or is run to the binding post marked GND. Once this second wire is found, it is opened somewhere between the lower end of the coil itself and the point at which it is grounded. The lower end of the coil is then connected to one end of a single resistor mount and the opposite terminal of the resistor mount is connected to one end of transposed down leads. The other down lead is connected through a similar resistance mount and resistor to the regular antenna binding post on the receiver. Reversing the leads does not, as a rule, make much difference, but it does no harm to try it. In some cases, performing this operation on the receiver brings about a tendency to oscillate when the volume control is run pretty well up. This is generally overcome by reversing the position of the plug going to the regular a.c. feed line.

The third fundamental type of antenna is one which is recommended for use in areas where the space available will not admit of the use of the horizontal doublet and where equal reception from all directions is desired. The mechanical details for such a system are given in the drawing, Figure 65. The length of a flat-top of this nature does not need to be as great as the length of a single wire for picking up the same signal voltage, but the flat-tops for any of the three systems described should be not less than thirty-five feet.

TUNED ANTENNAS FOR SHORT-WAVE CONVERTERS AND RECEIVERS

In consideration of the noise problems associated with short-wave reception, Harry D. Hooten, of Beech Hill, West Virginia, attacks the problem from a different point of view.

"How many times has foreign reception, around 25 meters, been impossible, due to interference from automobile ignition and power leaks? Having met with these conditions on several occasions, we began experimenting with various methods of noise reduction, with an eye for the most economical of practical systems. We found that the noise was generally worse when a ground was used—a discovery that led to the adoption of 'Zep' antenna. This reduced the noise to a surprisingly low level and actually provided a stronger signal than the grounded type of antenna system. Further experiments disclosed the fact that the flat-top, or horizontal wire, was unnecessary. A diagram of the modified aerial is shown in Figure 67 and is used where it is inconvenient to make any changes in the receiver or converter itself.

"When practical, however, it is desirable to alter the input circuit to conform with Figure 68, where C is a midget condenser having a maximum capacity of 100 mmfd. A 5-prong coil form is used (such as the National), and the antenna coil is wound on the negative filament end of the grid coil. A sufficient number of turns should be wound which will permit the antenna to be tuned either to the fundamental or a harmonic of the frequency being received. With this system, we have received GSB on 25 meters, with good volume, only a few doors from a power leak that ordinarily sounds like a backyard thunderstorm at this wavelength."

The arrangement suggested by Mr. Hooten will be effective only when the elimination of the ground connection does not upset the stability of the receiver or converter, or does not result in hum. Noise

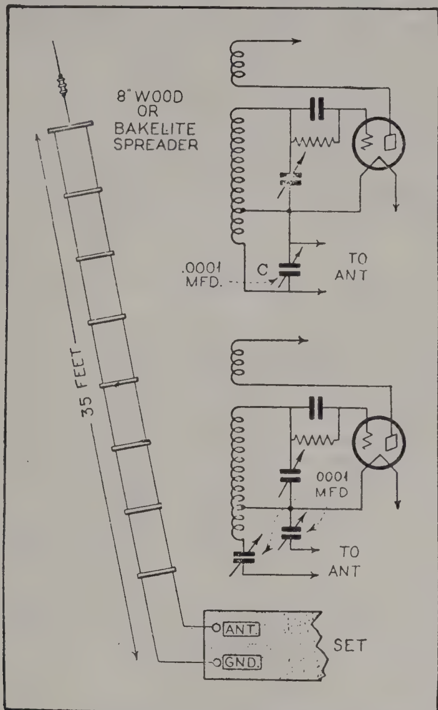


FIG. 67—LEFT. FIG. 68—UPPER RIGHT.
FIGURE 69—LOWER RIGHT.

reduction will, of course, be greatest at the fundamental or harmonic tuned frequencies of the antenna—somewhat of a disadvantage where simplicity of control is desired. However, with the resulting increased signal strength, this drawback will be largely discounted by the dyed-in-wool short-wave enthusiast. In some instances the circuit shown in Figure 69 may be preferable to the arrangement of Figure 68.

ANOTHER NOISE-REDUCING ANTENNA

"In the October Experimenters Department of Radio News I saw an article by Mr. Joseph Stokes on DX broadcast band reception with a filtered aerial. My work in this field extends back several years and I am giving herewith the results.

"Back in '29 I was working for a department store when I developed an antenna similar to that described by Mr. Stokes. This system

was designed to overcome interference (noise). The fact that the same system also resulted in extraordinary DX reception was to me merely incidental.

"The very fine results obtained with a properly designed antenna

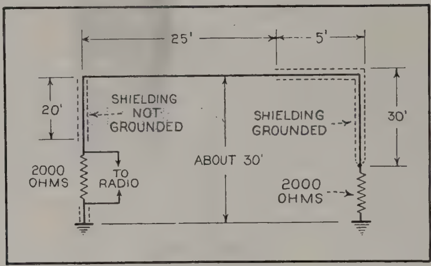


FIGURE 70

of this type may be accounted for to some extent by the fact that it is directional, greatly favoring signals coming from either end but relatively insensitive to those, or noise, coming from the sides. Its property of noise suppression is explainable on the same assumption: noise coming from either side will be greatly attentuated.

"The first of these aerials made was a 30 foot length of wire over which another wire was wound for almost the whole length of the first wire. Turns were spaced two inches apart. No electrical contact was made between the two wires. One of the wires was grounded at the far end and the other wire brought to the set. This aerial must be erected at right angles to the direction from which the interference comes in order to reduce the noise. This simple arrangement kept seven sets "sold" for the store.

"Since that time I have improved the antenna system and made it more efficient as shown in the sketch in Figure 70. The specifications for this installation are: Length of aerial 80 feet of Belden shielded

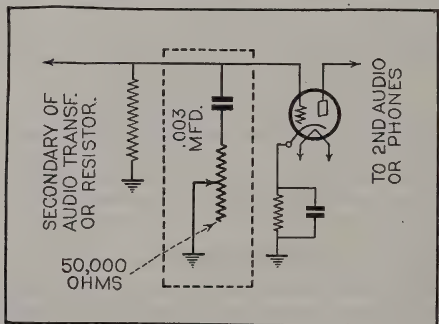


FIGURE 71

lead-in wire. This wire has 25 feet of its shielding removed, beginning at a distance of 35 feet from one end. This left a wire which

was shielded for a distance of 20 feet at one end and 35 at the other end leaving an unshielded space of about 25 feet between. The 20 foot section is the lead-in. Under no circumstances should the shield over the lead-in be grounded. At the other end of the aerial the opposite state obtains; and the end of the shield—not the core wire—is grounded to as good a ground as can be made via a resistor. The ground wire from the set is shielded and the shield is not grounded either to the set or to the ground. The two resistors are of 2000 ohms each; wire wound with a precision of at least 3% and non-inductive. They are mounted in cardboard tubes filled with paraffin wax. One is connected across the binding posts on the chassis with leads not exceeding 3 inches. The other is connected in series with the end of the wire shield at the far end of the aerial and as close to the ground as possible. It should preferably be mounted on the ground rod itself.

"The ground should be two six foot lengths of galvanized iron pipe for temporary jobs and copper or brass pipe for permanent in-

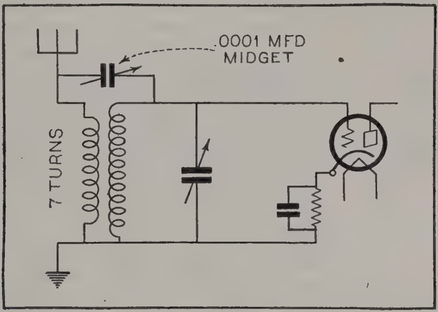


FIGURE 72

stallations. Don't use a water or gas line as a ground either for the set ground or for the aerial. Don't leave more than 3 inches of pipe or rod above the ground. Don't fail to solder all joints. Don't spare insulation. And don't do a slovenly job.

"If any readers put up a job like this, I would be glad to know the results obtained."

M. D. YANOSKO,
Pittsburgh, Pa.

NOISE CONTROL FOR S.W. SETS

"I found a noise control consisting of an .003 mfd. condenser and 50,000 ohm variable resistor indispensable on my short-wave set, see Figure 71. It minimizes QRM (interference) and heterodyne frequency whistles caused by two stations operating too close to the same frequency; also background noises of the receiver are greatly reduced. True some volume is sacrificed when the tone control is set for 'deep' but this drop in volume is compensated for by clear signals."

ALLEN D. RICKERT, JR.
Souderton, Pa.

SHORT-WAVE ANTENNA COUPLING IMPROVED

"With the following simple arrangement for coupling the antenna to the r.f. tube of a s.w. set, shown in Figure 72, I totally eliminated dead spots on all coils. There is also a decided increase in sensitivity, in the lower wavelengths around 20 meters."

ALLEN D. RICKERT, JR.
Souderton, Pa.

THE STATOMIT

Have you ever noticed in tuning a radio set that static is most noticeable between stations and that when you tune in a good strong signal the static disappears almost entirely? Wouldn't it be nice if we could go from one station to another without having any static between stations? Wouldn't it be even better if one could omit all of those signals which are chopped up with static and bring in only those signals which are strong enough to override and blanket out

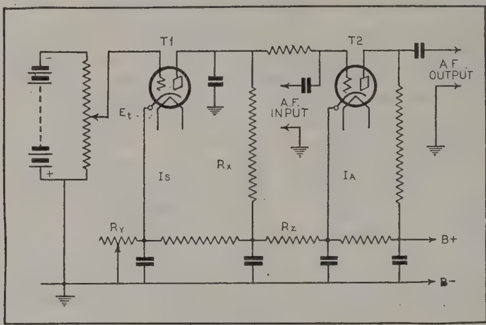


FIGURE 73

the static, leaving only undefiled, enjoyable music? This is exactly what is accomplished by the "Statomit" circuit described here. The amount of energy contained in crashes of static is really very small. The duration is so short that the forces acting do not have time to accumulate any measurable energy. This may seem strange, considering the terrific crashing noises in the loudspeaker, but it is true, nevertheless.

The energy in the radio wave is amplified through the radio-frequency end of the set and impressed upon the detector. At the time that it is stripped of its audio-frequency component, the radio-frequency component or carrier is rectified and used to provide an automatic volume-control bias voltage. This voltage is applied to the radio-frequency amplifier so as to mantain a constant volume. This same voltage is utilized in the system described here to operate a relay to silence the set between stations by controlling the audio amplifier in such a way that it is blocked except when a signal is tuned in.

A mechanical relay might be operated in the plate circuit of a

tube controlled by this automatic volume-control bias voltage by causing it to short circuit some portion of the audio-frequency amplifier, but such a relay would necessarily be delicate and subject to mechanical troubles such as bad contact, chattering sluggish action during cold weather, and would also cost much more than the scheme finally adopted.

In general, the outline of the scheme is such that this automatic volume-control bias voltage is amplified and applied to the grid return of one of the audio tubes in such a way as to completely block passage of any current. Further, the action is such that the effect is cumulative; that is, the energizing voltage applied to the amplifier tube is aided by the effect it causes. This insures that the action once started will carry through to completion without any possibility of lag or motorboating. The effect is one of complete and instantaneous cut-off.

The simplified circuit is shown in Figure 73. The automatic volume-control bias voltage is represented by a battery and potentiometer between ground and grid of T1, the tube employed to provide the "Statomit" action. When this voltage is zero and no signal is

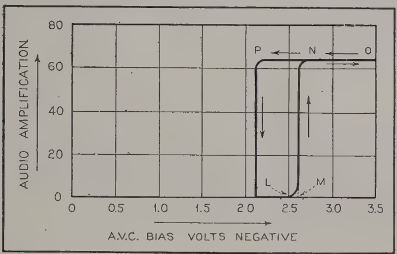


FIGURE 74

coming in, the grid is at such a voltage as to permit considerable current to flow from the plate of this tube through R_x, producing a voltage across R_x. This voltage is applied to the grid of the first audio tube (T2) and is sufficient to completely block this tube so that no static can come through.

If a signal is tuned in and a negative voltage generated by the rectifier, this negative voltage is applied to the grid of T1, completely blocking it, and the voltage across R_x falls to zero, unblocking the audio tube and permitting it to amplify and pass the signal through to the loudspeaker.

This action is cumulative and self-locking in such a way that when once started it carries itself through. This is accomplished in the following manner:

The voltage E_t on the grid of T1 is composed of the drop across R_y plus the automatic volume-control bias voltage. These voltages are in series aiding. The voltage across R_y is produced by total current composed of several constant currents plus the variable currents I_s and I_a. When the set is blocked, I_s is at a maximum and I_a is zero, therefore, only I_s is effective in helping to produce the voltage across R_y. When the set is operative, I_s is zero and I_a is at a maximum. Because maximum I_a is greater than maximum I_s, the

voltage across R_y will be greater when the set is operative than when the set is blocked. Now the voltage across R_y is aiding the voltage from the automatic volume-control tube, therefore when this automatic volume-control bias voltage builds up to the point where it operates to unblock the audio system, it is locked in this position by this aiding voltage.

This locking action is illustrated in the curve shown in Figure 74. Assume that the automatic volume-control bias voltage is zero and the set is operative. When the automatic volume-control bias increases until it reaches the point marked L, its effect is to produce a drop in voltage across R_x, permitting passage of small current to the audio tube so that I_s is decreasing and I_a is increasing. As soon as I_a becomes greater than I_s, the locking action takes place and instantly the curve shifts to point N. This action is controllable by condensers to prevent clicks and surges, but without such condensers the action is quite violent. Any further increase in the automatic volume-control bias can produce no further effect on I_a because I_s is already zero.

If the automatic volume-control bias is decreased because of lower signal voltage, it is necessary that it decreases to the point P before any effect is noted on I_a. It is necessary that I_s increase above I_a before the decrease in the voltage across R_y is effective. Instantly that point is noted, the current in I_a drops to zero and the set is completely blocked.

The distance between N and P may be adjusted by means of resistors R_x, R_y and R_z. It is adjusted to the point where fading of signals does not produce blocking of the set unless the fading is sufficient to produce the signal below the static level. This insures that when a signal is once tuned in it will remain until such times as it is useless for entertainment purposes.

The circuit actually used is shown in Figure 75. The tubes se-

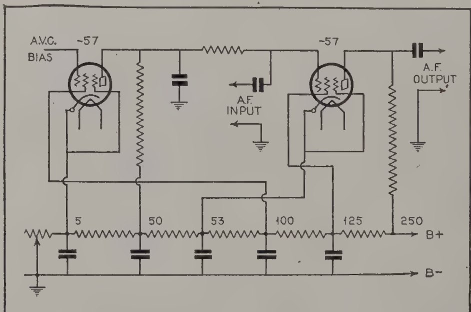


FIGURE 75

lected, as shown in this circuit, were more positive in their action than the triodes shown in Figure 73. The cut-off points are very definite in the –57 type tube and the screen-grid currents further aid in the action described previously.

The area L M N P L (Figure 74) may be shifted along the

abscissae by adjusting R_y. With a larger R_y aiding the automatic volume-control bias voltage, the operative point of the set is lowered to a more sensitive point so that fainter signals may be heard. The value of R_y may be increased to a point where the set is never blocked, even with the antenna shorted. This insures that even the faintest signals may be tuned in. The value of R_y may be decreased to the point where exceedingly strong signals are required to produce sufficient automatic volume-control bias to unblock the set. This enables the operator to set the level in such a manner that none but strong local stations can be heard.

This resistance R_y, in the form of a simple rheostat, is placed on the panel of the set, available to the operator's control. For ordinary home use it may be set in such a way that the receiver is absolutely quiet except to local stations, and these may be tuned in without hearing a sound on any part of the dial except where the local stations occur. If DX reception is desired, on the other hand, the listener can set this control for full sensitivity of the receiver so that the faintest signals may be heard at any part of the dial. In other words, the sensitivity of the set may be set at any point to suit the tastes of anyone.

CHAPTER 7

Short-Wave Station Lists

THE main reason why more short-wave stations are not heard by the average short-wave fan is because so little attention is paid to station schedules and wavelengths. For example, take station VK3ME at Melbourne, Australia. You might try for months for this station and never get it because you did not try between 5:00 and 6:30 a.m. on Wednesday or 5:00 and 7:00 a.m., Eastern Standard Time, on Saturday. For only at these times will you find this station on the air.

Now, most new short-wave listeners never reckon with time or wavelengths, but prefer to go tuning up and down the dials, expecting stations to come roaring in on the speaker like they do when you tune up and down the dials of a standard broadcast receiver. If the first turns of the dial do not bring forth signals from a number of stations, or if the first few stations tuned in do not include a distant one, they assume that the set is no good or short-wave reception is all "bunk".

Short-wave tuning is different from broadcast tuning. On the long waves we know almost when and where (on the dials) to find stations, for we grow accustomed to tuning them in day after day. But on a short-wave set we must search for the stations at first and then keep a record of the dial-reading in order to go back and get it later. It is not necessary to keep a written record always, as dial settings on a short-wave set soon get fixed in the mind just the same as on long waves. But you must search for the station at first, and to get it you must tune *when it is on the air!*

Short-wave stations usually tune very sharply. That is, they do not take up much space on the dial. In running up and down the dials you might pass over a distant station dozens of times and never know it is a station unless you happen to stop right on the exact spot where the signal is located. Therefore, you must tune slowly.

The best way for a beginner to proceed is: First spend a few days tuning in local stations, marking down the wavelengths and dial settings, and at the same time learning how to operate the dials and controls on the set. After a number of local stations have been logged, look in an up-to-date station list to learn just what stations are near the same wavelengths as the stations already logged. (Note—Short-wave stations are mostly experimental and change quite often. Be sure your station list is up to date and kept up to date or you will spend much time tuning for stations that are not on the air.) There follows an authentic short-wave station list of the world, compiled by the staff of RADIO NEWS from official Government sources.

World Short-Wave Station List

(All time given is Eastern Standard Time)

Meters	kc.	Call	Location	Service and Schedule
5.00	59,964	PK4PA	Palembang, Sumatra	Exp.
5.80	51,724	RW61	Moscow, U. S. S. R.	Broadcast
7.05	42,530	....	Berlin, Germany	Exp.
9.68	31,000	W8XI	Pittsburgh, Penna.	Exp.
9.80	30,593	IAG	Golfo Aranci, Sardinia	Exp.
10.06	29,803	IAF	Fiumicino, Italy	Exp.
10.79	27,800	W6XD	Palo Alto, Calif.	Exp.
11.55	25,960	G5SW	Chelmsford, England	Exp.
11.67	25,700	W2XBC	New Brunswick, N. J.	Exp.
12.31	24,380	VE9GW	Bowmanville, Ont.	Broadcast
12.48	24,000	W6XQ	San Mateo, Calif.	Exp.
13.45	22,291	GBU	Rugby, England	Phone
13.92	21,540	W8XK	Saxonburg, Penna.	Exp. 7 A.M.—2 P.M.
13.97	21,470	GSH	Daventry, England	Broadcast
14.01	21,420	W2XDJ	Deal, N. J.	Exp.
14.01	21,420	WKK	Lawrenceville, N. J.	Ph to LSN; 8 A.M., 4 P.M
14.01	21,420	WLO	Lawrence, N. J.	Transatlantic phone
14.17	21,215	LSL	Buenos Aires, Argentina	Phone to GAA
14.19	21,130	LSM	Buenos Aires, Argentina	Phone to Europe
14.25	21,060	WKA	Lawrenceville, N. J.	Phone to England; 8 A.M. —4 P.M.
14.27	21,020	LSN	Buenos Aires, Argentina	Ph to WLO; 8 A.M., 4 P.M.
14.28	21,000	OKI	Podebrady, Czechoslovakia	Phone
14.47	20,730	LSY	Buenos Aires, Argentina	Phone
14.50	20,680	LSX	Buenos Aires, Argentina	Phone to U. S.
14.50	20,680	LSN	Buenos Aires, Argentina	Phone to Europe, after 10.30 P.M.
14.50	20,680	FSR	Saigon, Indo-China	Phone to Paris
14.54	20,620	PMB	Bandoeng, Java	Phone to PCK
14.62	20,500	W9XF	Chicago, Ill.	Exp.
14.72	20,380	GBA	Rugby, England	Phone to ships and LSN
14.88	20,140	DWG	Nauen, Germany	Phone to LSG; tests at 10 A.M. and 3 P.M.
14.96	20,040	OPL	Leopoldville, Belgian Congo	Phone to ORG
14.97	20,028	DHO	Nauen, Germany	Phone
15.03	19,947	DIH	Nauen, Germany	Phone
15.08	19,906	LSG	Buenos Aires, Argentina	Phone to FTM
15.10	19,850	WMI	Deal, N. J.	Phone
15.12	19,830	FTD	Ste. Assise, France	Phone
15.14	19,820	WKN	Lawrenceville, N. J.	Phone to England; 8 A.M. —4 P.M.
15.21	19,720	EAQ	Madrid, Spain	Phone to S. America
15.24	19,680	CEC	Santiago, Chili	Phone
15.45	19,400	FRO, FRE	Ste. Assise, France	Phone
15.55	19,300	FTM	Ste. Assise, France	Phone 10 A.M.—noon
15.57	19,260	PPU	Rio de Janeiro, Brazil	Phone to FTM
15.58	19,240	DFA	Nauen, Germany	Phone to XDA
15.60	19,220	WNC	Deal, N. J.	Transatlantic phone
15.60	19,220	WKF	Lawrenceville, N. J.	Phone to England; 8 A.M. —4 P.M.
15.62	19,200	ORG	Brussels, Belgium	Phone
15.77	19,020	WKW-W2XBJ	Rocky Point, L. I.	Tests
15.82	18,960	LSR	Buenos Aires, Argentina	Phone
15.87	18,892	WDS	Rocky Point, L. I.	Phone
15.90	18,890	ZSS	Klipheuvel, S. Africa	Phone to England
15.94	18,820	PLE	Bandoeng, Java	Phone to Holland; 8.40—10.40 A.M.
16.06	18,680	OCI	Lima, Peru	Tests
16.10	18,620	GBJ	Bodmin, England	Phone to Montreal
16.11	18,610	GBU	Rugby, England	Phone to New York
16.12	18,600	PDM	Kootwijk, Holland	Phone
16.27	18,440	HJY	Bogota, Colombia	Phone to CEC and LSR

16.29	18,400	PCK	Kootwijk, Holland	Phone
16.32	18,382	FZA	Saigon, Indo-China	Phone to Paris
16.33	18,370	PNC	Bandoeng, Java	Phone
16.35	18,350	ZLW	Wellington, N. Z.	Phone to VK2ME
16.35	18,350	WND	Deal Beach, N. J.	Phone
16.36	18,340	WLA	Lawrenceville, N. J.	Transatlantic phone
16.38	18,310	FZS	Saigon, Indo-China	Phone to Paris
16.38	18,310	GBS	Rugby, England	Phone to New York
16.39	18,295	YVQ	Maracay, Venezuela	Phone
16.44	18,240	FRO-FRE	Ste. Assise, France	Phone
16.44	18,240	FTE	Ste. Assise, France	Phone
16.48	18,193	GAW	Rugby, England	Phone
16.49	18,180	CGA	Drummondville, Que	Phone to England
16.52	18,145	PMC	Bandoeng, Java	Phone to PCV 3.10—9:20 A.M.
16.56	18,105	W9XAA	Chicago, Ill.	Exp.
16.56	18,100	GBK	Bodmin, England	Phone
16.65	18,020	KQJ	Bolinas, Calif.	Transpacific phone
16.80	17,850	PLF	"Radio Malabar," Bandoeng, Java	Phone
16.80	17,850	W2XAO	New Brunswick, N. J.	Exp.
16.82	17,830	PCV	Kootwijk, Holland	Phone to Java
16.87	17,780	W8XK	Saxonburg, Penna.	Broadcast, relays KDKA
16.87	17,780	W3XAL	Bound Brook, N. J.	Exp., relays WJZ
16.88	17,770	GSG	Daventry, England	Broadcast
16.88	17,770	PHI	Huizen, Holland	Exp., irregular
16.88	17,760	DJE	Koenigswusterhausen, Ger.	Phone
16.92	17,719	HSP	Bangkok, Siam	Phone
17.00	17,640	GFWV	S. S. Majestic	Phone
		GLSQ	S. S. Olympic	Phone
		GDLJ	S. S. Homeric	Phone
		GMJQ	S. S. Belgenland	Phone
		GTSD	S. S. Monarch of Bermuda	Phone
		GKFY	S. S. Minnetonka	Phone
		GMBJ	S. S. Empress of Britain	Phone
17.12	17,512	DFB	Nauen, Germany	Phone
17.24	17,400	J1AA	Tokio, Japan	Phone to Australia
17.34	17,300	W8XL	Dayton, Ohio	Exp.
17.34	17,300	W6XAJ	Oakland, Calif.	Exp.
17.34	17,300	W2XCU	Ampere, N. J.	Exp.
17.34	17,300	VE9BY	London, Ont.	Exp., irregular
17.37	17,260	DAF	Norddeich, Germany	Phone
17.51	17,122	HAS	Szekesfehervar, Hungary	Phone
17.52	17,120	WOO	Deal, N. J.	Phone
17.52	17,120	W2XDO	Ocean Gate, N. J.	Exp.
17.55	17,080	GBC	Rugby, England	Phone
18.00	16,665	DAN	Norddeich, Germany	Tests with ships
18.40	16,305	PCL	Kootwijk, Holland	Phone to Bandoeng, from 7 A.M.
18.40	16,270	WLO	Lawrence, N. J.	Phone to England
18.50	16,200	FZR	Saigon, Indo-China	Phone to Paris
18.55	16,162	PSA	Rio de Janeiro, Brazil	Phone
18.56	16,150	GBX	Rugby, England	Phone
18.68	16,060	NAA	Arlington, Va.	Time; 11.57—noon
18.71	16,030	KKP	Kauhuku, Hawaii	Phone to KWO
18.80	15,950	PLG	Bandoeng, Java	Phone, afternoons
18.90	15,860	FTK	Ste. Assise, France	Phone to Saigon
19.36	15,490	J1AA	Tokio, Japan	Exp.
19.46	15,410	KWO	Dixon, Calif.	Phones Hawaii, 2—7 P.M.
19.54	15,344	KWU	Dixon, Calif.	Phone to Hawaii, 2—7 P.M.
19.56	15,330	W2XAD	Schenectady, N. Y.	Broadcast; Mo., We., Fri., 3—4 P.M., Sunday 2—4 P.M.
19.58	15,300	OXY	Lyngby, Denmark	Exp.
19.65	15,270	W2XE	Wayne, N. J.	Broadcast, relays WABC
19.68	15,243	FYA	Pontoise, France	Broadcast; 5—8 A.M.
19.72	15,210	W8XK	Saxonburg, Penna.	Broadcast, relays KDKA
19.73	15,200	DJB	Zeesen, Germany	Broadcast
19.76	15,190	VE9BA	Montreal, Que.	Exp.
19.81	15,140	GSF	Daventry, England	Broadcast
19.81	15,130	VE9DN	Montreal, Que.	Exp.
19.83	15,120	J1AA	Tokio, Japan	Broadcast, irregular, A.M.

19.83	15,120	HVJ	Vatican City, Italy	Broadcast; 5.00—5.15 A.M. daily
19.85	15,104	RAU	Tashkent, U.S.S.R.	Broadcast
19.90	15,075	TI4NRH	Heredia, Costa Rica	Broadcast
19.92	15,051	....	Hialeah, Florida	Phone to Panama and S. America
19.99	15,000	CM6XJ	Central Tuinucu, Cuba	Broadcast, irregular
20.08	14,930	HJB	Bogota, Colombia	Phone
20.23	14,706	WKU-W2XBJ	Rocky Point, L. I.	Tests; daytime
20.42	14,690	PSS	Rio de Janeiro, Brazil	Phone
20.50	14,620	XDA	Mexico City	Phone
20.60	14,550	HBJ	Geneva, Switzerland	Testing
20.65	14,530	WMN	Lawrenceville, N. J.	Phone to England
20.65	14,530	LSA	Buenos Aires, Argentina	Phone to England
20.69	14,545	RXC	Panama City	Phone to Florida
20.70	14,480	LSN	Buenos Aires, Argentina	Phone
20.70	14,480	GBW	Rugby, England	Phone to New York
20.73	14,460	WMF	Lawrenceville, N. J.	Transatlantic phone
20.80	14,420	VPD	Suva, Fiji Islands	Phone
20.95	14,310	G2NM	Sonning-on-Thames	Broadcast
21.17	14,150	KKZ	Bolinas, Calif.	Phone
21.52	13,950	YO1	Bucharest, Rumania	Broadcast
21.53	13,925	WIK	Rocky Point, L. I.	Phone
21.63	13,860	WIY-W2XBJ	Rocky Point, L. I.	Tests
21.72	13,811	SUZ	Abu Zabal, Egypt	Phone to England
21.77	13,780	KKW	Bolinas, Calif.	Phone
21.82	13,740	CGA	Drummondville, Que.	Phone
21.90	13,690	KKZ	Bolinas, Calif.	Tests, irregular
21.93	13,671	HAS	Szekesfehervar, Hungary	Phone
22.06	13,591	GBC	Rugby, England	Phone to Canada and ships
22.26	13,480	WAJ	Rocky Point, N. Y.	Tests
22.38	13,400	WND	Deal Beach, N. J.	Transatlantic phone
22.40	13,380	WMA	Lawrenceville, N. J.	Phone
22.58	13,285	CGA	Drummondville, Que	Phone to England
22.68	13,220	GFWV	S. S. Majestic	Phone
		GLSQ	S. S. Olympic	Phone
		GMJQ	S. S. Belgenland	Phone
		GDLJ	S. S. Homeric	Phone
		VTSX	S. S. Monarch of Bermuda	Phone
		GKFY	S. S. Minnetonka	Phone
		GMBJ	S. S. Empress of Britain	Phone
22.93	13,074	J1AA	Kemikawa-Cho, Japan	Phone
23.00	13,040	DDAC	S. S. Europa	
		DDAS	S. S. Bremen	
		DDBR	S. S. Berlin	
		DDCB	S. S. Columbus	
		DDCG	S. S. Resolute	
		DDCP	S. S. Cap Polonio	
		DDDT	S. S. Deutschland	
		DDDX	S. S. Hamburg	
		DDEA	S. S. Cap Arcona	
		DDED	S. S. New York	
		DDFF	S. S. Reliance	
		DDFT	S. S. Oceana	
		DDNY	S. S. Albert Ballin	
23.38	12,830	....	Rabat, Morocco	Broadcast; 7.30—9 A.M., Sundays
23.45	12,795	IAC	Coltana, Italy	Tests
23.46	12,780	GBC	Rugby, England	Phone
24.19	12,394	DAF	Norddeich, Germany	Phone to ships
24.40	12,290	ZLW	Wellington, N. Z.	Phone
24.40	12,290	PLM	Bandoeng, Java	Phone
24.40	12,290	GBU	Rubgy, England	Phone to New York
24.46	12,250	FTN	Ste. Assise, France	Phone
24.46	12,250	GBS	Rugby, England	Phone
24.46	12,250	PLM	Bandoeng, Java	Phone to Holland
24.60	12,150	GBS	Rugby, England	Transatlantic phone
24.68	12,150	FQO, FQE	Ste. Assise, France	Phone
24.89	12,045	NAA	Arlington, Va.	Time signals; 11.57—noon
24.89	12,045	NSS	Annapolis, Md.	Time signals; 9.57—10 P.M.
24.99	12,000	FZG	Saigon, Indo-China	Time Signals; 2—2.05 P.M.

25.02	11,980	FZS	Saigon, Indo-China	Phone to FTK 6-10 A.M.
25.10	11,950	KKQ	Bolinas, Calif.	Exp.
25.10	11,950	FTA	Ste. Assise, France	Phone to Rabat, irr. 7-11 A.M.
25.16	11,923	RW50	Moscow, U. S. S. R.	Broadcast
25.20	11,900	FYA	Pontoise, France	Broadcast for Madagascar 11.15 A.M. 1.15 P.M. daily
25.21	11,895	VE9DR	Montreal, Que.	Exp.
25.24	11,880	W9XF	Downer's Grove, Chicago, Ill.	Exp.
25.25	11,870	W8XK	Saxonburg, Pa.	Relays KDKA; 4.30-10 P.M. daily
25.26	11,870	VUC	Calcutta, India	Broadcast
25.28	11,865	GSE	Daventry, England	Broadcast
25.30	11,860	VE9CA	Calgary, Alta.	Exp.
25.34	11,840	W9XAA	Chicago, Ill.	Relays WCFL
25.35	11,835	VE9HX	Halifaz, N. S.	Exp.
25.36	11,830	W2XE	Wayne, N. J.	Broadcast; relays WABC 2-4 P.M. daily
25.40	11,810	I2RO	Rome, Italy	Broadcast; 11.30 A.M.—12.30 P.M.; 1.15-6 P.M. daily
25.42	11,800	W1XAL	Boston, Mass.	Broadcast; irr.
25.47	11,780	VE9DR	Drummondville, Que.	Exp.
25.51	11,760	XDA	Mexico City	Exp.; tests with XAM
25.51	11,760	DJD	Zeesen, Germany	Broadcast
25.53	11,750	GSD	Daventry, England	Broadcast
25.56	11,730	PHI	Huizen, Holland	Broadcast; irr.
25.60	11,720	VE9JR	Winnipeg, Man.	Broadcast
25.63	11,705	FYA	Pontoise, France	Broadcast; 3-5 P.M.; 6-10 P.M.
25.63	11,705	VE9BA	Montreal, Que	Exp.
25.65	11,695	YVQ	Maracay, Venezuela	Exp.
25.68	11,680	KIO	Kahuku, Hawaii	Phone to KES
25.73	11,660	PPQ	Rio de Janeiro, Brazil	Exp.; irr.
26.00	11,530	CGA	Drummondville, Can.	Phone
26.00	11,530	XAM	Merida, Yucatan	Tests with XDA
26.10	11,490	GBK	Bodmin, England	Phone
26.15	11,470	IBDK	S. S. Elettra, Marconi's Yacht	Exp.
26.22	11,435	DHC	Nauen, Germany	Phone
26.46	11,340	DAN	Norddeich, Germany	Time signals; 7 A.M., 7 P.M.
26.83	11,180	CT3AQ	Funchal, Madeira	Broadcast; Tue., Thurs. 5-6.30 P.M.; Sun. 10.30 A.M.—noon
27.00	11,111	XFD	Mexico City, Mex.	Broadcast
27.28	10,990	ZLT	Wellington, N. Z.	Phone
27.30	10,980	ZLW	Wellington, N. Z.	Exp.
27.35	10,975	OCI	Lima, Peru	Phone to HJY
27.68	10,840	KWV	Dixon, Calif.	Phone to Hawaii
28.04	10,770	GBP	Rugby, England	Phone
28.09	10,675	WNB	Lawrenceville, N. J.	Phone to Bermuda
28.12	10,670	CEC	Santiago de Chili	Exp.
28.22	10,630	PLR	Bandoeng, Java	Phone to Holland and France
28.28	10,610	WEA	Rocky Point, N. Y.	Exp.
28.44	10,540	WOK	Lawrence, N. J.	Phone to LSN
28.50	10,525	VLK-VK2ME	Sydney, Australia	Phone to GBP
28.80	10,410	PDK	Kootwyk, Holland	Phone
28.80	10,410	KEZ	Bolinas, Calif.	Exp.
28.80	10,410	LSY	Buenos Aires, Arg.	Phone
28.80	10,410	UIG	Medan, Sumatra	Phone to Java and VLK 3 A.M.- 8 A.M.
28.80	10,410	KWZ	Dixon, Calif.	Phone
28.87	10,390	GBX	Rugby, England	Phone
28.99	10,350	LSX	Buenos Aires, Arg.	Exp.
29.04	10,330	ORK	Brussels, Belgium	Phone to OPM
29.12	10,300	LSL	Buenos Aires, Arg.	Phone to Europe
29.16	10,290	DIQ	Koenigswusterhausen, Ger.	Exp.
29.25	10,250	PMN	Bandoeng, Java	Phone
29.35	10,220	PSH	Rio de Janeiro, Brazil	Exp.

29.50	10,163	DDAC	S. S. Europa	Phone
29.50	10,163	DDAS	S. S. Bremen	Phone
29.50	10,163	DDBR	S. S. Berlin	Phone
29.50	10,163	DDCB	S. S. Columbus	Phone
29.50	10,163	DDCG	S. S. Resolute	Phone
29.50	10,163	DDCP	S. S. Cap Polonio	Phone
29.50	10,163	DDDT	S. S. Deutschland	Phone
29.50	10,163	DDDX	S. S. Hamburg	Phone
29.50	10,163	DDEA	S. S. Cap Arcona	Phone
29.50	10,163	DDED	S. S. New York	Phone
29.50	10,163	DDFF	S. S. Reliance	Phone
29.50	10,163	DDFT	S. S. Oceana	Phone
29.50	10,163	DDNY	S. S. Albert Ballin	Phone
29.56	10,150	DIS	Nauen, Germany	Press
29.59	10,140	OPM	Leopoldville, Belgian Congo	Phone to ORK
29.70	10,100	EHY	Madrid, Spain	Exp.
29.84	10,055	ZFB	Hamilton, Bermuda	Phone to WNB
29.84	10,055	SUV	Abu Zabal, Cairo, Egypt	Phone to GAA
29.98	10,000		Belgrade, Yugoslavia	Broadcast
30.09	9,970	KAZ	Manila, P. I.	Phone to PLV
30.10	9,964	LSL	Buenos Aires, Arg.	Phone to WLO
30.15	9,950	GCU	Rugby, England	Phone
30.20	9,930	HJY	Bogota, Colombia	Phone to OCI
30.30	9.900	LSN	Buenos Aires, Arg.	Phone to Europe and WLO
30.33	9,890	LSA	Buenos Aires, Arg.	Phone
30.40	9,860	WMI	Lawrenceville, N. J.	Phone to England
30.40	9,860	WON	Lawrence Township, N. J.	Phone
30.40	9,860	EAQ	Madrid, Spain	Broadcast; 5.30-7 P.M. daily; Sat. 1-3 P.M.; 5.30-7 P.M.
30.40	9,860	JIAA	Kemikawa-Cho, Japan	Exp.
30.47	9,840	FTI	Ste. Assise, France	Phone
30.64	9,800	GCW	Rugby, England	Phone to U. S.
30.68	9,772	EAM	Madrid, Spain	Broadcast
30.74	9,760	VLK-VK2ME	Sydney, Australia	Phone to Java
30.77	9,750	WOF	Lawrenceville, N. J.	Phone to England
30.77	9,750	WNC	Deal, N. J.	Phone
30.90	9,700	GCA	Rugby, England	Phone
30.90	9,700	WMI	Deal, N. J.	Phone
30.90	9,700	LQA	Buenos Aires, Arg.	Phone
31.00	9,675	TI4NRH	Heredia, Costa Rica	Broadcast; daily except Sunday 5.30-6.30 P.M.
31.10	9,640	HSP2	Bangkok, Siam	Broadcast
31.20	9,620	DGU	Nauen, Germany	Phone to Egypt
31.23	9,600	LGN	Bergen, Norway	Phone
31.23	9,600	XETE	Mexico City, Mex.	Broadcast; 2.30-5.30 P.M. 7-11 P.M.
31.23	9,600	LQA	Buenos Aires, Arg.	Phone
31.23	9,592	CT1AA	Lisbon, Portugal	Broadcast; 5-7 T
31.27	9,590	VK2ME	Sydney, Australia	Broadcast; Sunday mornings
31.28	9,585	W3XAU	Byberry, Penna	Broadcast; relays WCAU
31.28	9,585	VE9DR	Montreal, Que.	Exp.
31.28	9,585	GSC	Daventry, England	Broadcast
31.30	9,580	HBL	Geneva, Switzerland	Broadcast; Sun. 5-5.45 P.M.
31.33	9,570	WIXAZ	Springfield, Mass.	Broadcast; 4.30-12 P.M. daily
31.33	9,570	SRI	Poznan, Poland	Broadcast
31.36	9,560	DJA	Zeesen, Germany	Broadcast
31.48	9,530	W2XAF	Schenectady, N. Y.	Broadcast; 7-10 P.M. Sun., Mon., Wed., Fri.; 7-11 P.M. Thurs., Sat.
31.51	9,520	OXY	Skamlebaek, Denmark	Broadcast; temporarily changed to 49.5 meters
31.55	9,510	VK3ME	Melbourne, Australia	Broadcast
31.55	9,510	GSB	Daventry, Eng.	Broadcast
31.58	9,500	PRBA	Rio de Janeiro, Brazil	Broadcast
31.58	9,500	YV3BC	Caracas, Venezuela	Exp.
31.60	9,490	WEF-W2XBJ	Rocky Point, N. Y.	Exp.
31.63	9,480	PLW	Bandoeng, Java	Phone to Australia
31.71	9,455	WKJ	Rocky Point, N. Y.	Exp.
31.74	9,450	WES-W2XBJ	Rocky Point, N. Y.	Exp.

31.86	9,415	PLV	Bandoeng, Java	Phone. 4-8 A.M.
31.90	9,400	XDC	Mexico City, Mex.	Exp.
31.97	9,375	XDA	Mexico City, Mex.	Phone
31.97	9,375	EH9OC	Berne, Switzerland	Phone
32.00	9,370	CT3AQ	Funchal, Madeira	Broadcast
32.10	9,330	CGA	Drummondville, Que.	Phone to GBK; 6 P.M.-6 A.M.
32.33	9,280	GCB	Rugby, England	Phone to ships, irr.
32.40	9,250	GBK	Bodmin, England	Phone to CGA; 6 P.M.-6 A.M.
33.61	9,200	GBS	Rugby, England	Transatlantic phone
32.70	9,170	YVR	Maracay, Venezuela	Phone to Europe
32.72	9,162	WNA	Lawrenceville, N. J.	Phone to England
32.93	9,104	LST	Olivos, Argentine	Phone
33.00	9,091	XFD	Mexico City, Mex.	Exp.
33.00	9,091	XDA	Mexico City, Mex.	Exp.
33.26	9,020	GCS	Rugby, England	Phone to WND
33.30	9,010	KEJ	Bolinas, Calif.	Exp.
33.50	8,955	TGX	Guatemala City	Exp.
33.52	8,950	WEL-W2XBJ	Rocky Point, N. Y.	Exp.
33.59	8,925	WEC	Rocky Point, N. Y.	Exp.
33.70	8,900	ZLT	Wellington, N. Z.	Phone to VLK
33.79	8,870	NPO	Cavite, P. I.	Time signals 9.55-10 P.M.
33.79	8,870	NAA	Arlington, Va.	Time signals 9.55-10 P.M. 2.55-3 P.M.
33.95	8,830	GDLJ	S. S. Homeric	Phone
33.95	8,830	GFWV	S. S. Majestic	Phone
33.95	8,830	GKFY	S. S. Minnetonka	Phone
33.95	8,330	GLSQ	S. S. Olympic	Phone
33.95	8,830	GMBJ	S. S. Empress of Britain	Phone
33.95	8,830	GMJQ	S. S. Belgenland	Phone
33.95	8,830	VTSX	S. S. Monarch of Bermuda	Phone
34.13	8,790	TIR	Cartago, Costa Rica	Phone; afternoons
34.50	8,690	W2XAC	Schenectady, N. Y.	Exp.
34.56	8,680	GBC	Rugby, England	Phone to ships; afternoons
34.68	8,630	WOO	Deal, N. J.	Phone
35.00	8,566	IBEJ	S. S. Conto Rosso	Phone
35.00	8,566	ICEJ	S. S. Rex	Phone
35.00	8,566	IDLI	S. S. Conto de Savoia	Phone
35.02	8,570	RV15	Khabarovsk, Siberia	Broadcast
35.02	8,570	WOO	Ocean Gate, N. J.	Phone to ships
35.42	8,470	DAF	Norddeich, Ger.	Phone to ships
35.50	8,450	PRAG	Porto Alegre, Brazil	Phone
36.00	8,328	DDAC	S. S. Europa	Phone
36.00	8,328	DDAS	S. S. Bremen	Phone
36.00	8,328	DDBR	S. S. Berlin	Phone
36.00	8,328	DDCB	S. S. Columbus	Phone
36.00	8,328	DDCG	S. S. Resolute	Phone
36.00	8,328	DDCP	S. S. Cap Polonio	Phone
36.00	8,328	DDDT	S. S. Deutschland	Phone
36.00	8,328	DDDX	S. S. Hamburg	Phone
36.00	8,328	DDEA	S. S. Cap Arcona	Phone
36.00	8,328	DDED	S. S. New York	Phone
36.00	8,328	DDFF	S. S. Reliance	Phone
36.00	8,328	DDFT	S. S. Oceana	Phone
36.00	8,328	DDNY	S. S. Albert Ballin	Phone
36.65	8,185	PSK	Rio de Janeiro, Brazil	Phone to WOK
36.92	8,125	PLW	Bandoeng, Java	Phone
37.03	8,100	JIAA	Tokio, Japan	Exp.
37.03	8,100	EATH	Vienna, Austria	Phone
37.04	8,110	HCJB	Quito, Ecuador	Broadcast
37.33	8,035		Rabat, Morocco	Broadcast; Sun, 3-5.30 P.M.
37.59	7,980	VLJ	Sydney, Australia	Phone to Java
37.77	7,940	VK2ME	Sydney, Australia	Exp.
37.80	7,940	DOA	Doeberitz, Germany	Phone
38.00	7,890	VPD	Suva, Fiji Islands	Phone
38.07	7,880	J1AA	Tokio, Japan	Tests with KEL
38.11	7,870	RXC	Panama City	Phone to HJP; afternoons
38.29	7,830	PDV	Kootwijk, Holland	Phone
38.49	7,790	HBP	Geneva, Switzerland	Phone; Sun. 5—4.45 P.M.
38.60	7,770	FTF	Ste. Assise, France	Phone

38.59	7,758	PCK	Kootwijk, Holland	Phone 9 A.M.—7 P.M.
38.86	7,715	KEE	Bolinas, Calif.	Exp.
39.01	7,685	TIR	Cartago, Costa Rica	Phone
39.16	7,660	FTL	Ste. Assise, France	Phone
39.34	7,630	RIM	....U. S. S. R.	Phone to RKI; 6 A.M.—8.15 A.M.
39.42	7,610	KWX	Dixon, Calif.	Phone to Hawaii; nights
39.65	7,560	KWY	Dixon, Calif.	Phone to Hawaii
39.82	7,530	....	"El Prado", Riobamba, Ecuador	Broadcast; Thu. 9—11 P.M.
39.89	7,520	KDK-KKH	Kauhuku, Hawaii	Phone to KWO; 9 P.M.—2 A.M.
39.97	7,500	RKI	Moscow, U. S. S. R.	Phone to RIM; 6 A.M.—8.15 A.M.
40.16	7,470	HJB	Bogota, Colombia	Phone; Irr.
40.30	7,444	HBQ	Geneva, Switzerland	Phone
40.46	7,410	WEG	Rocky Point, N. Y.	Phone
40.50	7,402	HJ3ABD	Bogota, Colombia	Broadcast; 9–11 P.M. daily
40.54	7,400	WEM-W2XBJ	Rocky Point, N. Y.	Exp.
40.60	7,390	ZLT	Wellington. N. Z.	Phone to Sydney; mornings
40.71	7,370	KEQ	Kauhuku, Hawaii	Phone to California; nights
40.90	7,320	ZTJ	Johannesburg, S. Africa	Phone
41.00	7,300	HSP2	Bangkok, Siam	Broadcast
41.60	7,207	EAR58	Teneriffe, Canary Islands	Broadcast; daily 5—6.30 P.M., Sundays 7.30—9 A.M.
41.67	7,195	VK6AG	Perth, Australia	Exp.
41.67	7,195	VS1AB	Singapore, British Malaya	Broadcast; Mo., Wed., Fri. 9.30—11 A.M.
41.93	7,150	HJ4ABB	Manizales, Colombia	Broadcast; Sat. 11 P.M.—midn.
42.10	7,120	HKK	Cali, Colombia	Broadcast
42.20	7,105	HKN	Medellin, Colombia	Broadcast
42.30	7,090	HKE	Bogota, Colombia	Broadcast; Mo. 6—7 P.M. Tue., Fri. 8—9 P.M.
43.71	7,020	EAR125	Madrid, Spain	Broadcast
43.00	6,976	EAR110	Madrid, Spain	Broadcast
43.23	6,940	WEB	Rocky Point, N. Y.	Exp.; tests with Europe; irr.
43.45	6,900	GDS	Rugby, England	Phone to New York; nights
43.54	6,890	KEQ	Kauhuku, Hawaii	Phone to Calif.; nights
43.73	6,860	KEL	Bolinas, California	Phone
43.70	6,860	....	"Radio Vitus" Paris, France	Broadcast
43.82	6,840	CFA	Drummondville, Que	Phone
44.15	6,790	GDB	Rugby, England	Phone
44.41	6,755	WOA	Lawrenceville, N. J.	Phone to England; nights
44.41	6,755	WOB	Lawrenceville, N. J.	Phone to Bermuda; nights
44.54	6,732	WEJ-W2XBJ	Rocky Point, N. Y.	Exp.
44.61	6,720	WQO	Rocky Point, N. Y.	Phone
44.71	6,705	WER	Rocky Point, N. Y.	Phone
44.91	6,675	DGK	Nauen, Germany	Tests with WEJ, near 9 P.M.
44.98	6,667	XFD	Mexico City	Phone
45.02	6,660	HKM	Bogota, Colombia	Broadcast 9—11 P.M.
45.02	6,660	TGW	Guatemala City	Broadcast
45.09	6,650	IAC	Coltana, Italy	Exp.
45.29	6,620	....	"El Prado", Riobamba, Ecuador	Broadcast; Thu. 9–11 P.M.
45.36	6,610	REN	Moscow, U. S. S. R.	Broadcast; 1—6 P.M.
46.05	6,510	WOO	Deal, N. J.	Phone
46.27	6,480	TGW	Guatemala City	Broadcast
46.63	6,430	PCM	The Hague, Holland	Broadcast
46.67	6,425	W3XL	Bound Brook, N. J.	Exp.
46.70	6,420	RV62	Minsk, U. S. S. R.	Broadcast
47.00	6,380	HJ5ABD	Cali, Colombia	Broadcast
47.00	6,380	HC1DR	Quito, Ecuador	Broadcast
47.33	6,335	VE9AP	Drummondville, Que	Broadcast
47.97	6,250	HJ3ABF	Bogota, Colombia	Broadcast; 7—11 P.M. daily
47.97	6,250	CN8MC	Casablanca, Morocco	Broadcast; relays Rabat
48.20	6,220	I2RO	Rome, Italy	Broadcast
48.51	6,180	TGW	Guatemala City	Broadcast; 1.30 — 2.30 P.M., 5 P.M.—midn. irr.

48.75	6,150	VE9CL	Winnipeg, Man.	Broadcast
48.86	6,140	W8XK	Saxonburg, Penna.	Broadcast; relays KDKA, 4.15 P.M.—1 A.M.
48.91	6,130	YV3BC	Caracas, Venezuela	Broadcast; 8—10 P.M
48.91	6,130	VE9BA	Montreal, Que.	Broadcast
48.95	6,125	YV11BMO	Maracaibo, Venezuela	Broadcast; 8—11 P.M.
48.99	6,120	ZTJ	Johannesburg, So. Africa	Broadcast
48.99	6,120	W2XE	Wayne, N. J.	Broadcast; relays WABC
49.07	6,112	YV1BC	Caracas, Venezuela	Broadcast; 5.15—10 P.M.
49.10	6,110	VE9HX	Halifax, N. S.	Broadcast; 8.30 — 11.15 A.M.; 5 P.M.—10 P.M.
49.10	6,110	VE9CG	Calgary, Alta.	Broadcast
49.10	6,110	VUC	Calcutta, India	Broadcast; mornings
49.15	6,100	W3XAL	Bound Brook, N. J.	Broadcast; relays WJZ, Sat. 4.30 P.M.—midn.
40.15	6,100	W9XF	Chicago, Ill.	Broadcast; relays WENR, 3.30 P.M.—1 A.M. daily except Sat.
49.19	6,095	VE9GW	Bowmanville, Ontario	Broadcast; Mo., Tu. 7 A.M.—11 A.M.; Thu., Fri. 3—7 P.M.; Sat. 3 P.M.—11 P.M.; Sun. 10 A.M.—8 P.M.
49.23	6,090	VE9BJ	St. John, N. B.	Broadcast
49.31	6,080	VE9EH	Charlottetown, P. E. I.	Broadcast
49.31	6,080	W9XAA	Chicago, Ill.	Broadcast
49.40	6,070	OXY	Skamlebaek, Denmark	Broadcast; 2—6.30 P.M.
49.40	6,070	ZTJ	Johannesburg, So. Africa	Broadcast
49.40	6,070	UOR2	Vienna, Austria	Broadcast
49.40	6,070	VE9CS	Vancouver, B.C.	Broadcast; Fri., 12.30—1.45 A.M. Sun.; noon—midn.
49.44	6,065	SAJ	Motala, Sweden	Broadcast
49.48	6,060	VQ7LO	Nairobi, Kenya, Africa	Broadcast; 11 A.M.—2 P.M. daily
49.48	6,060	W3XAU	Byberry., Penna.	Broadcast; relays WCAU Thur., Fri. 6.15 A.M.—midn.; other days 6.15 A.M.—3 P.M.
49.48	6,060	W8XAL	Cincinnati, Ohio	Broadcast; relays WLW
49.48	6,060	ZL2ZX	Wellington, N. Z.	Broadcast
49.56	6,050	GSA	Daventry, England	Broadcast
49.64	6,040	W1XAL	Boston, Mass.	Broadcast; Sundays
49.64	6,040	PK3AN	Soerabaja, Java	Broadcast
49.64	6,040	W4XB	Miami Beach, Fla	Broadcast
49.72	6,030	VE9CA	Calgary, Alta	Broadcast
49.80	6,020	XEW	Mexico, D. F., Mexico	Broadcast
49.80	6,020	DJC	Zeesen, Germany	Broadcast; 7—9 P.M.
49.84	6,015	VE9CX	Wolfville, N. S.	Broadcast
49.93	6,005	VE9DR	Montreal, Quebec	Broadcast; relays CTCF
49.93	6,005	VE9DN	Montreal, Que.	Broadcast
49.97	6,000	RV59	Moscow, U. S. S. R.	Broadcast; daily 2—5 P.M
49.97	6,000	ZL3ZC	Christchurch, N. Z.	Broadcast
49.97	6,000	HJ1ABB	Barranquilla, Colombia	Broadcast; 7.45 — 10.30 P.M. daily; 8—10.30 P.M. Mo., Wed.; 7.45—8.30 P.M. Sunday
50.22	5,970	HVJ	Vatican City, Italy	Broadcast; 2—2.15 P.M. daily; 5—5.30 P.M. Sunday
50.47	5,940	TGX	Guatemala City	Broadcast; 1.30—2.30 P.M. 5 P.M.—midn.
50.60	5,925	HJ4ABE	Medellin, Colombia	Broadcast; Mo. 7—11 P.M.; Wed., Fri. 7.30—10.30 P.M.; Tue., Thu., Sat. 6.15—8 P.M.
50.99	5,880	XDA	Mexico, D. F., Mexico	Tests with XAM; 10 A.M.—8 P.M. irr.
50.99	5,880	H2ABA	Tunja, Colombia	Broadcast; 1—2 P.M.; 7.30—10 P.M.
51.09	5,868	WOB	Lawrenceville, N. J.	Phone to Bermuda
51.69	5,800	HJ1ABB	Barranquilla, Colombia	Broadcast; daily

51.96	5,770	XAM	Merida, Yucatan	Tests with XDA 10 A.M.—8 P.M. irr.
52.60	5,700	HCK	Quito, Ecuador	Broadcast 8—11 P.M
52.69	5,690	TIUI	Tananarive, Madagascar	Broadcast
52.79	5,680	VK3LR	Melbourne, Australia	Exp.; 5—7.30 A.M.
57.00	5,260	WQN	Rocky Point, N. Y.	Tests irreg.
57.99	5,170	OK1MPT	Prague, Chechoslovakia	Broadcast
57.99	5,170	PMB	Soerabaja, Java	Broadcast
58.22	5,150	PMY	Bandoeng, Java	Phone to Australia; 11 A.M.
59.13	5,070	WCN	Lawrenceville, N. J.	Phone to England, nights
59.37	5,050	VRT-ZFA	Hamilton, Bermuda	Phone to WNB and GMBJ nights
60.20	4,980	GBC	Rugby, England	Phone to ships
60.33	4,970	G6RX	Rugby, England	Exp., evenings 9 P.M.
61.95	4,840	GDW	Rugby, England	Phone to U. S. evenings
62.46	4,800	W2XV	Long Island City, N. Y.	Exp.
62.65	4,785	CGA	Drummondville, Que.	Phone to ships
62.70	4,782	W9XAM	Elgin, Ill.	Time sigs.
62.86	4,770	ZL2XX	Wellington, N. Z.	Phone
63.12	4,750	WOO	Ocean Gate, N. J.	Phone to ships
63.12	4,750	WKF	Lawrence, N. J.	Phone to England; evenings
66.48	4,510	VPN	Nassau, Bahama Is.	Phone to WND; 2—10 P.M.
67.07	4,470	YID	Bagdad, Iraq	Phone
69.44	4,320	G6RX	Rugby, England	Exp.; 9 P.M. irr.
69.56	4,310	WTDV-WTDW	Virgin Is.	Exp.; Weather reports 2—3 P.M.
70,00	4,283	IBEJ	S. S. Conte Rosso	Phone
		ICEJ	S. S. Rex	Phone
		IDLI	S. S. Conte di Savoia	Phone
70.20	4,270	RV15	Khabarovsk, Siberia	Broadcast
70.20	4,270	WIR	Rocky Point, N. Y.	Phone
71.73	4,180	GFWV	S. S. Majestic	Phone
		GLSQ	S. S. Olympic	Phone
		GMJQ	S. S. Belgenland	Phone
		GDLJ	S. S. Homeric	Phone
		GTSD	S. S. Monarch of Bermuda	Phone
		GFKY	S. S. Minnetonka	Phone
		GMBJ	S. S. Empress of Great Britain	Phone
		DDAC	S. S. Europa	Phone
		DDAS	S. S. Bremen	Phone
		DDCB	S. S. Columbus	Phone
		DDCG	S. S. Resolute	Phone
		DDCP	S. S. Cap Polonio	Phone
		DDDT	S. S. Deutschland	Phone
		DDDX	S. S. Hamburg	Phone
		DDDE	S. S. Cap Arcona	Phone
		DDED	S. S. New York	Phone
		DDFF	S. S. Reliance	Phone
		DDFT	S. S. Oceana	Phone
		DDNY	S. S. Albert Ballin	Phone
72.87	4,116	WOO	Deal, N. J.	Phone
73.00	4,107	HCJB	Quito, Ecuador	Broadcast; daily except Mo.
73.21	4,100	WND	Hialeah, Florida	Phone to VPN; irr.
79.95	3,750	I8RO	Rome, Italy	Broadcast
79.95	3,750	F8KR	Constantine, Tunis	Broadcast

CHAPTER 8

S. W. DX, Best Bets, Reception Reports

FOR listeners who desire to "fish" for stations, the following set of rules is given. Due to the effect of light on short waves, certain wavelengths will not carry to any great distance at certain times of the day or night. From 14 to 20 meters tuning should be done from daybreak till about 5 p.m., local time. From 20 to 33-meter stations to the east of the listener come in best between 11 a.m. and 10 p.m. And on the same wavelengths stations to the west of the listener come in best from about 1 a.m. till about two hours after daybreak. From 33 to 75 meters, distant stations can be heard only when there is darkness between the listener and the station, and this means tuning should be done at night.

After all, it *does not require an expert* to get results on short waves and it is not a trick of magic to tune in many distant stations. All that is required is a good receiver, some common sense and up-to-date information on short-wave stations, schedules and wavelengths.

As an example of a well-prepared short-wave time schedule there is printed below a time schedule of Short-Wave Best Bets, a list of stations logged during the past month at the RADIO NEWS Short-Wave Listening Post in Westchester County, New York. The schedule includes only the best received stations, hourly, from 5 o'clock in the morning to 12 midnight, E. S. T. Space has been left for filling in local time. Space has also been left opposite the call letters for your own dial settings for each station you pick up. Unless otherwise noted stations are heard daily.

Short-Wave "Best Bets"

Wavelengths in Meters	***Call Letters***
5 A. M. Eastern Standard Time	
30.5	J1AA
31.2+ Sun.	VK2ME
31.5 Wed., Sat.	VK3ME
70.2	RV15
6 A. M. Eastern Standard Time	
16.9	GSG
19.8	GSF
30.5	J1AA
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5 Wed., Sat.	VK3ME
49.4+ Irregular	W8XAL
70.2	RV15
7 A. M. Eastern Standard Time	
13.9+	W8XK
16.9	GSG
19.6	FYA
19.8	GSF
23.3+ Sun.	RABAT
31.2+ Sun.	VK2ME
31.3+	W1XAZ
49.2 Mon., Tues.	VE9GW
49.4+ Irregular	W8XAL
70.2	RV15

8 A. M. Eastern Standard Time	
13.9+	W8XK
16.8+ Irregular	PHI
19.6	FYA
19.7	DJB
19.8	GSF
23.3+ Sun.	RABAT
25.4	I2RO
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5+	GSB
31.8+	PLV
49.0+	VE9HX
49.2 Mon., Tues., Sun.	VE9GW
49.4+ Irregular	W8XAL
49.9+	VE9DR
70.2	RV15
9 A. M. Eastern Standard Time	
13.9+	W8XK
16.8+ Irregular	PHI
19.6	FYA
19.7	DJB
19.7	W8XK
19.8	GSF
25.4	I2RO
25.6 Except Sun.	VE9JR
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5+	GSB

Wavelengths in Meters	*Call Letters*
31.8+	PLV
49.0+	VE9HX
49.2 Mon., Tues., Sun.	VE9GW
49.4+ Irregular	W8XAL
49.9+	VE9DR

10 A. M. Eastern Standard Time

13.9+	W8XK
16.8+ Irregular	PHI
19.6	FYA
19.6+	W2XE
19.7	W8XK
19.7	DJB
19.8	GSF
25.4	I2RO
25.5 Irregular	DJD
26.8+ Sun.	CT3AQ
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5+	GSB
31.5+	YV3BC
31.8+	PLV
49.0+	VE9HX
49.2 Mon., Tues., Sun.	VE9GW
49.4+ Irregular	W8XAL
49.9+	VE9DR

11 A. M. Eastern Standard Time

13.9+	W8XK
19.6+	W2XE
19.7	W8XK
19.7	DJB
19.8	GSF
25.2	FYA
25.2	W8XK
25.4	I2RO
25.5 Irregular	DJD
25.6 Except Sun.	VE9JR
26.8+ Sun.	CT3AQ
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5+	GSB
31.5+	YV3BC
49.0+	VE9HX
49.2 Mon., Tues., Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.9	VE9BJ
49.9+	VE9DR

12 NOON Eastern Standard Time

13.9+	W8XK
19.7	W8XK
19.7	DJB
19.8	GSF
25.2	FYA
25.4	I2RO
25.5 Irregular	DJD
25.6 Sat.	VE9JR
31.2+	W3XAU
31.2+ Sun.	VK2ME
31.3+	W1XAZ
31.5+	GSB
31.5+	YV3BC
49.2 Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.9	VE9BJ
49.9+	VE9DR

1 P. M. Eastern Standard Time

16.8 Except Sat.	W3XAL
19.7	W8XK
19.7	DJB
25.2	FYA
25.4	I2RO
25.5	GSD
25.5 Irregular	DJD
25.6 Sat.	VE9JR
30.4 Sat.	EAQ
31.3+	W1XAZ
31.5	GSB
31.5+	YV3BC
49.2 Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.5	W3XAU
49.5 Temporary	OXY
49.9+	VE9DR
50.0+	HVJ

2 P. M. Eastern Standard Time

16.8 Except Sat.	W3XAL
19.5 Sun.	W2XAD
19.7	W8XK
19.7	DJB
25.2	FYA
25.3+	W2XE
25.4	I2RO
25.5 Irregular	DJD
25.5	GSD
25.6 Except Sat., Sun.	VE9JR
30.4 Sat.	EAQ
31.2+	XETE
31.3	HEL (code)
31.3+	W1XAZ
31.5+	GSB
31.5+	YV3BC
49.2 Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.5	W3XAU
49.5 Temporary	OXY
49.6+ Sun.	W1XAL
49.9+	VE9DR

3 P. M. Eastern Standard Time

16.8 Except Sun.	W3XAL
19.5+ Ex. Tu., Th., Sat.	W2XAD
19.7	W8XK
25.2	W8XK
25.3+	W2XE
25.4	I2RO
25.5 Irregular	DJD
25.5	GSD
25.6	FYA
25.6 Ex. Sat., Sun	VE9JR
30.4 Sat.	EAQ
31.2+	XETE
31.3+	W1XAZ
31.3+	DJA
31.5+	GSB
31.5+	YV3BC
32.3 Sun.	RABAT
45.3+ (chimes)	REN
48.8+	W8XK
49.1+ Except Sat.	W9XF
49.2 Th., Fr., Sat., Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.5 Temporary	OXY
49.6+ Sun	W1XAL
49.9+	VE9DR
50.0	RV59

Wavelengths in Meters	*Call Letters*
4 P. M. Eastern Standard Time	
16.8 Except Sun.	W3XAL
25.2	W8XK
25.3+	W2XE
25.4	I2RO
25.5	GSD
25.5	DJD
25.6	FYA
31.2+	XETE
31.2+ Tues., Fri.	CT1AA
31.3+	W1XAZ
31.3+	DJA
31.5+	GSB
31.5+	YV3BC
32.3 Sun.	RABAT
46.7 Irregular	W3XL
48.8+	W8XK
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.1 Except Sat.	W9XF
49.2 Thu., Fri., Sat., Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+ Irregular	W8XAL
49.5 Temporary	OXY
49.5	W3XAU
49.9+	VE9DR
50.0	RV59
5 P. M. Eastern Standard Time	
16.8 Except Sun.	W3XAL
19.8	HVJ
25.2	W8XK
25.3+	W2XE
25.4	I2RO
25.5	GSD
25.5	DJD
26.8+ Tues., Thurs.	CT3AQ
30.4	EAQ
31.0	TI4NRH
31.2+ Tues., Fri.	CT1AA
31.2+	XETE
31.3 Sun.	HBL
31.3+	W1XAZ
31.3+	DJA
31.5+	GSB
31.5+	YV3BC
32.3	RABAT
38.4+ Sun.	HBP
46.7 Irregular	W3XL
48.8+	W8XK
49.0	W2XE
49.0+	VE9HX
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.1+ Except Sat.	W9XF
49.2 Th., Fri., Sat., Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+	W8XAL
49.5	W3XAU
49.5 Temporary	OXY
49.9	VE9DR
50.0	RV59
50.6 Irregular	HJ4ABE
6 P. M. Eastern Standard Time	
19.8	GSF
25.2	W8XK
25.6	FYA
26.8+ Tues., Thurs.	CT3AQ
30.4	EAQ
31.0	TI4NRH
31.2+ Tues., Fri.	CT1AA
31.2+	XETE
31.3+	W1XAZ
31.3+ Irregular	DJA
31.4+	W2XAF
31.5+	GSB
31.5+	YV3BC
48.8+	W8XK
49.0	W2XE
49.0+	VE9HX
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.1+ Except Sat., Sun.	W9XF
49.2 Th., Fri., Sat., Sun.	VE9GW
49.3+	W9XAA
49.4+ Sun.	W8XAL
49.5 Temporary	OXY
49.9+	VE9DR
50.6 Tues., Thurs., Sat.	HJ4ABE
7 P. M. Eastern Standard Time	
19.8	GSF
25.2	W8XK
25.6 Except Sun.	VE9JR
25.6	FYA
31.0	TI4NRH
31.2+	XETE
31.3+	W1XAZ
31.3+	DJA
31.4+	W2XAF
31.5+	GSB
31.5+	YV3BC
48.8+	W8XK
49.0	W2XE
49.0+	VE9HX
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.2 Sat., Sun.	VE9GW
49.3+ Sun.	W9XAA
49.4+	W8XAL
49.5	W3XAU
49.8	DJC
49.9+	VE9DR
50.6 Except Sun.	HJ4ABE
8 P. M. Eastern Standard Time	
25.2	W8XK
25.6	FYA
25.6 Except Sun.	VE9JR
31.2+	XETE
31.3+	W1XAZ
31.3+	DJA
31.4+	W2XAF
31.5+	YV3BC
48.8+	W8XK
49.0	W2XE
49.0+	VE9HX
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.1+ Except Sat.	W9XF
49.2 Sat.	VE9GW
49.3+ Sun.	W9XAA
49.4+	W8XAL
49.5	W3XAU
49.8	DJC
49.9+	VE9DR
50.5	HJ1ABB
50.6 Except Sun.	HJ4ABE
51.0	HJ2ABA
73.0+	HCJB
9 P. M. Eastern Standard Time	
25.6	FYA
25.6 Except Sat.	VE9JR
31.0	TI4NRH

Wavelengths in Meters	*Call Letters*
31.2+	XETE
31.3+ Irregular	DJA
31.3+	W1XAZ
31.4+	W2XAF
31.5+	YV3BC
40.5+	HJ3ABD
45.3 Thurs.	PRADO
48.8+	W8XK
49.0	W2XE
49.0+	VE9HX
49.1+	YV1BC
49.1+ Sat.	W3XAL
49.1+ Except Sat.	W9XF
49.2 Sat.	VE9GW
49.3+ Sun.	W9XAA
49.4+	W8XAL
49.5	W3XAU
49.8 Irregular	DJC
49.9+	VE9DR
50.5	HJ1ABB
50.6 Mon., Wed., Fri.	HJ4ABE
51.0	HJ2ABA
73.0 Except Mon.	HCJB
10 P. M. Eastern Standard Time	
25.6	FYA
31.0	TI4NRH
31.2+	XETE
31.3+	W1XAZ
40.5+	HJ3ABD
45.3 Thurs.	PRADO
45.0 Fri.	TGW
48.8+	W8XK
49.0	W2XE
49.1+ Sat.	W3XAL
49.1+ Except Sat.	W9XF
49.2 Sat.	VE9GW
49.4+	W8XAL
49.5	W3XAU
49.9+	VE9DR
50.5 Thurs.	HJ1ABB
50.6 Mon., Wed., Fri.	HJ4ABE
11 P. M. Eastern Standard Time	
19.8	GSF
25.6 Sat.	VE9JR
31.2+	XETE
31.3+	W1XAZ
45.0 Fri.	TGW
48.8+	W8XK
49.1+ Sat.	W3XAL
49.1+ Except Sat.	W9XF
49.2 Sat.	VE9GW
49.4+	W8XAL
49.5	W3XAU
49.9+	VE9DR

Station Locations

Wave-Length	*Call Letters*	*Location*
13.9+	W8XK	Pittsburgh, Pa.
16.8+	W3XAL	Bound Brook, N. J.
16.8+	PHI	Huizen, Holland
16.9	GSG	Daventry, England
19.5	W2XAD	Schenectady, N. Y.
19.6	FYA	Pontoise, France
19.6+	W2XE	New York, N. Y.
19.7	W8XK	Pittsburgh, Pa.
19.7	DJB	Zeesen, Germany
19.8	GSF	Daventry, England
19.8	HVJ	Vatican City
23.3		Rabat. Morocco
25.2	FYA	Pontoise, France
25.2	W8XK	Pittsburgh, Pa.
25.3	GSE	Daventry, England
25.3+	W2XE	New York, N. Y.
25.4	I2RO	Rome, Italy
25.5	GSD	Daventry, England
25.5	DJD	Zeesen, Germany
25.6	FYA	Pontoise, France
25.6	VE9JR	Winnipeg, Canada
26.8+	CT3AQ	Funchal, Madeira
30.4	EAQ	Madrid. Spain
31.0	TI4NRH	Heredia, Costa Rica
31.2+	XETE	Mexico City
31.2+	W3XAU	Philadelphia, Pa.
31.2+	VK2ME	Sydney, Australia
31.2+	CT1AA	Lisbon, Portugal
31.3	HBL	Geneva, Switzerland
31.3	GSC	Daventry, England
31.3+	W1XAZ	Springfield, Mass.
31.3+	DJA	Zeesen, Germany
31.4+	W2XAF	Schenecatdy, N. Y.
31.5	VK3ME	Melbourne, Australia
31.5+	YV3BC	Caracas, Venezuela
31.5+	GSB	Daventry, England
31.8+	PLV	Bandoeng, Java
32.3		Rabat, Morocco
38.4+	HBP	Geneva, Switzerland
40.5+	HJ3ABD	Bogota, Colombia
45.0	TGW	Guatemala
45.3	PRADO	Riobamba, Ecuador
45.3+	FEN	Moscow, U. S. S. R.
48.8+	W8XK	Pittsburgh, Pa.
49.0	W2XE	New York, N. Y.
49.0+	VE9HX	Halifax, N. S.
49.1+	YV1BC	Caracas, Venezuela
49.1+	W3XAL	Bound Brook, N. J.
49.1+	W9XF	Chicago, Ill.
49.2	VE9GW	Bowmanville, Can.
49.3+	W9XAA	Chicago, Ill.
49.4+	W8XAL	Cincinnati, Ohio
49.5	W3XAU	Philadelphia, Pa.
49.5	OXY	Skamleback, Denmark
49.6	GSA	Daventry, England
49.6+	W1XAL	Boston, Mass.
49.8	DJC	Zeesen, Germany
49.9	VE9BJ	New Brunswick, Can.
49.9+	VE9DR	Montreal, Can.
50.0	RV59	Moscow, U. S. S. R.
50.0+	HVJ	Vatican City
50.5	HJ1ABB	Barranquilla,Colombia
50.6+	HJ4ABE	Medellin, Colombia
51.0	HJ2ABA	Tunja, Colombia
70.2	RV15	Khabarovsk, Siberia
73.0	HCJB	Quito, Ecuador

The above time schedule appears each month, revised to date, in RADIO NEWS. To show that short-wave reception of foreign stations

all around the world is quite a common thing amongst well informed RADIO NEWS short-wave listeners, we print a few reports of reception from various readers of the magazine.

USING A CONVERTER

Mr. T. S. Robinson of Watervliet, New York, reports the following stations, DJB, Pontoise, W2XAD, GSF, FYA, I2RO, VE9JR, EAQ, VK2ME, W1XAZ, W2XAF, GSB, VK3ME, HBP, W3XL, W8XK, YV1BC, W3XAL, W9XF, W2XE, W8RAL, GSA, W1XAL, and VE9DR, on a small Midwest converter using four tubes ahead of a Radiola 80. Enclosed with his letter is a question, "Don't you think this is pretty good for an inexpensive converter?"

BEST RECEPTION IN FLORIDA

Stations received best here during the last month are: W8XK, W1XAZ, I2RO, DJA, XDA, VE9DR, VK3ME, DJB, EAQ, HJB, PRADO, W3XAU, W9XF, W3XAL, W2XE, W2XAF, W4XB, VK2ME, FYA, GSA, GSC, GSB, YV1BC, DJD. All stations listed above come in with good loudspeaker volume. Equipment used: Model 112 Philco BC receiver with Philco 4C converter. E. M. Law, Miami, Fla.

DX RECEPTION IN OREGON

The best short-wave reception, here, is Pontoise, EAQ, VK2ME, VK3ME, W8XK. My receiver is home-made. On the long waves I have DX'ed the following: JOJK, Kanazawa; JOQK, Nugata; XGOA, Nanking, China; 2YA, Wellington, Australia; 2CO, Corowa, Australia; 3AR, Melbourne, Australia; 5CK, Crystalbrook, Australia; 4QG, Brisbane, Australia; 2BL, Sydney, Australia; 4RK, Rockhampton, Australia. Best reception from Australia and the Orient on the broadcast band is gotten from 1:30 to 3 a.m. M.S.T. G. E. Dubbe, Freewater, Ore.

BEST STATIONS FOR SOUTH CAROLINA

Some of the best receptions I have are from EAQ, GSA, GSB, I2RO, FYA, DJB, CT1AA, VK3ME. I use a National NC5 converter with a good broadcast set and also a Scott DeLuxe all-wave set. E. F. Bahan, Greenville, S. C.

RECEPTION IN NEW MEXICO

I have the L16 Midwest set and have no trouble at all bringing in VK2ME, VK3ME, Venezuela, and a station in New Zealand. New York stations come in loud enough to drive one out of the house. B. L. Ward, Albuquerque, N. Mex.

DX IN NEW YORK STATE

RV59 is very good here lately, 3:30 to 4 p. m. and in some cases up to 5 p. m. E.S.T. on 50 meters. I noted last month you listed

CKPR on 48 meters. This is a harmonic. I wrote them regarding this and they verified it, 48 meter harmonic. YV1BC is as strong as a local. They play chimes each quarter hour. HJ1ABB (formerly HKD) is heard very strong now. HJ4ABE, is right on 51 meters at present. H. S. Bradley, Hamilton, N. Y.

RECEPTION IN MISSOURI

I get a new German station on practically the same wave as old G5SW, daily, from 1:30 to 3:30 p. m. The signal is exceptionally strong, far above the noise level. VK2ME and VK3ME are now being received with great strength. GSA on 49.6 meters is being very strongly received. GSB on 31.54 meters is not so well received. FYA on 25.2 and 25.6 meters is being strongly received daily. Other strong stations are I2RO, VE9JR and VE9DR as well as YV1BC and EAQ. C. H. Long, Winston, Mo.

RECEPTION IN MAINE

My set is built from a plan described in RADIO NEWS by Chesley Johnson. Listed below are the best short-wave stations: W8XK, EAQ, W2XAF, GSC, GSB, W9XF, W9XAA, GSA, W3XAU, W1XAL, VE9GW, VE9DR, VE9DN. The last station is at Montreal, Canada, on 49.96 meters. I also get station XER, Mexico, on 735 kc. I have had one station in Japan on 1111 kilocycles. I understood him to say JFBK. Can anyone confirm this? R. I. Keeler, West Scarboro, Maine.

A REPORT FROM ARLINGTON, MASS.

I have a home-built regenerative receiver using two tubes and I regularly receive best GSC and GSB, London and EAQ, Spain. I also hear station VE9GW extremely well and heard them announce their schedule as follows: Fridays 4 p. m. to midnight, Saturdays, noon to 4 p. m., Sundays 11 a. m. to 8 p. m. B. Eldon Short, Arlington, Mass.

REGULAR RECEPTION IN GOLDSBORO, N. C.

Mr. Jasper Forehand reports the following list as heard regularly: DJD, CKI, EAQ, LCI, CMB (Canton, China), EAM (Madrid, Spain), EAV, IRM, LSX and LSN (Buenos Aires), KTS (Lazy Bay, Alaska), FYC, SKZ, TIR, DIK, XBB, JAP, MRT, LCJ, HHA, HBQ, CMR, GIK, PJS, FTF, GSB and GSA (Daventry, England).

BEST RECEPTION IN OHIO

Mr. Louis Du Bois, of Yorkville, Ohio, reports the following best bets: VK3ME, VK2ME, EAQ, FYA, GSA, GSC, YV1BC, I2RO, HBI, DJA, DJC, RV59, VE9GW, VE9DR, W1XAZ, W8XK, W3XAL, W3XAU, W9XAA, W9XF, W2XE. He uses a Midwest four-tube converter ahead of a Gulbransen eight-tube receiver.

INTERNATIONAL MORSE CODE

A	• —
B	— • • •
C	— • — •
D	— • •
E	•
F	• • — •
G	— — •
H	• • • •
I	• •
J	• — — —
K	— • —
L	• — • •
M	— —
N	— •
O	— — —
P	• — — •
Q	— — • —
R	• — •
S	• • •
T	—
U	• • —
V	• • • —
W	• — —
X	— • • —
Y	— • — —
Z	— —
Ä (German)	• — • —
Á or Å (Spanish-Scandinavian)	• — — • —
CH (German-Spanish)	— — — —
É (French)	• • — • •
Ñ (Spanish)	— — • — —
Ö (German)	— — — •
Ü (German)	• • — —
1	• — — — —
2	• • — — —
3	• • • — —
4	• • • • —
5	• • • • •
6	— • • • •
7	— — • • •
8	— — — • •
9	— — — — •
0	— — — — —

Period	• • • • • •
Semicolon	— • — • — •
Comma	• — • — • —
Colon	— — — • • •
Interrogation	• • — — • •
Exclamation point	— — • • — —
Apostrophe	• — — — — •
Hyphen	— • • • • —
Bar indicating fraction	— • • — •
Parenthesis	— • — — • —
Inverted commas	• — • • — •
Underline	• • — — • —
Double dash	— • • • —
Distress Call	• • • — — — • • •
Attention call	— • — • —
General inquiry call	— • — • — — • —
From (de)	— • • •
Invitation to transmit (go ahead)	— • —
Warning—high power	— — • • — —
Question (please repeat after ......)—interrupting long messages.	• • — — • •
Wait	• — • • •
Break (Bk.) (double dash)	— • • • —
Understand	• • • — •
Error	• • • • • • • •
Received (O. K.)	• — •
Position report (to precede position messages)	— • — •
End of each message (cross)	• — • — •
Transmission finished (end of work) (conclusion of correspondence)	• • • — • —

FIGURE 79

CHAPTER 9

Learning the Code

THERE are very few young men who at some time during their life have not been fascinated by the mysterious dots and dashes of the telegraph code. And it is far from the mark that only boys are interested in code. Many of our wealthiest men, holding enormously responsible positions, have their own radio shacks where they spend many fascinating hours communicating with ordinary "hams" in all parts of the globe. But it is equally true that every growing boy, and especially the Boy Scout, should learn the code; it may be useful and even save life at some time in the future.

In the beginning, Morse signals were sent over the land-line and recorded by embossing them on a strip of paper. It was purely accidental that the art of receiving the signal by sound was discovered. Some of the old-time operators, after watching the recording for many years, found that they could read the signals by the sound of the electromagnet. That was the beginning of "reading" by sound.

In radio, the sound is somewhat different from the signals over the land-line, since the receiving operator hears a sustained musical tone which has the duration of the dots and dashes. In the land-line system there is a click at the beginning and end of each dot or dash.

Beginners have usually had to learn the code by having an experienced operator send to them. If the teacher happened to be a poor operator—and some of them were—the students had a hard time of it and were greatly handicapped.

Obviously the ambition of every radio operator is the ability to copy three to six words behind the transmission, easily and accurately, with either pen or "mill." It is equally obvious that such a worthy ambition may be realized if one goes about it the right way.

The ability to copy behind is neither a trick nor a gift. No one

ever became a skilled telegraph operator in a "hit-or-miss" way, any more than has any one ever become a skilled musician, surgeon, typist, tennis player, or in fact, anything that requires skill. Skill is the result of properly directed training, whether it is a typist whose flying fingers never strike the wrong key while her trained eye is following the copy, or a surgeon whose trained hand guides the sharp knife unerringly through a myriad of infinitesimal veins and nerves near the heart or brain, or a radio operator copying fast stuff 3 to 6 words behind, accurately and without that tense nervous and mental strain so common with the unskilled. If you learn to do a particular task correctly at the beginning, and continue doing it—over and over—without deviation, eventually you can accomplish it without having to "think" about it, consciously. You perform it semi-automatically. Your sub-conscious mind does it without the persistent direction of the conscious mind. If you make a false start, pursue wrong methods, or undertake to teach yourself without the infallible guide of experience, you will become confused and uncertain and soon you will be wandering around in a circle like a traveler who has lost his way in a strange forest.

The chief characteristics of bad sending are lack of consistency in "timing," "spacing," "character-formation," and poor "speed."

Here is a very necessary thing to know about the dits and dahs of which Continental-Morse code consists. A dit is short—as short as you possibly can make it, whether sending 2 words per minute or 50 words per minute. It always is made the same way. There is no other way to make it. There are no slow and fast dits any more than there are long, short and medium dahs. A dah is exactly three times longer than a dit, regardless of speed.

So long as you believe there are variations in the length of dahs and that dits may be made slow or fast, as the mood strikes, you will not make any progress toward becoming a skilled operator.

Examine the dit characters—e,i,s,h,5., and the dah characters—t,m,o,O. They will serve to illustrate our fundamental principle. The code characteristics are shown in the accompanying chart in Figure 79. When transmitting the word "his" at, say, 10 wpm., you make the four dits of the "h" as fast as you can, without cramping your arm or squeezing the key, uniformly, thus (. . . .) then you allow the space of four dahs to intervene before making the "i" thus (. .) and the space of four dahs before making the "s" thus (. . .).

When you start out to send 10 wpm speed, maintain that speed. Be consistent. If you allow the space of two dahs between two letters, three dahs between two more and four or five between two more, your speed is inconsistent and hard to copy.

Bear in mind always that your sending speed is increased and decreased by the length of your spaces, not by the speed of your individual signals. At 10 wpm., you will send the word "his" like this—"h——i——s." At 20 wpm., you will send it thus—"h—i—s." At 30 wpm., thus—"h-i-s." Beyond that speed you can soon learn to regulate your own spacing uniformly if you have patiently come up from the 5 to 8 wpm rate uniformly and developed your "timing sense" which is as necessary to code transmission as it is to music. You must practice until you can time your signals automatically.

The first necessity is uniformity in making dits and dahs. There is only one length of dah (–) not (—) or (———). The joining of your dits or dahs in parts of a letter must be uniformly done or you make something else than what you intended. Example, the letter "v." If made thus (···–) it is "st." If thus (· · ·–) it is "ia." If (. . . –) it is "eeet." If thus (· . . –) it is "eu." So you will readily understand that "v," like all the signals of Continental code, can be transmitted but the one way, thus (. . . –).

Skill, then, is the result of repetition. The man who has half a dozen or more different styles of penmanship never becomes a skilled penman, and so with any and everything, but most particularly does this apply to transmitting code.

You send and write with your hand. The motive power of your hand is supplied by the muscles of your fingers, wrist, forearm, upper arm, neck, shoulders and back. The controlling power of the muscles is supplied by the nerves, which are amenable to the brain. We learn to telegraph, hence it is an intellectual process. When we

FIGURE 80

succeed, through certain procedure, in tying it up with our instincts, it becomes what we term "second nature," just as do most of our other acquirements. When, through a process of co-ordinative training, we can transmit and receive code without conscious thought as to how many dits make the letter "h" and how many dahs make the letter "o", and varying combinations for other signals, we become skilled proportionately. Lack of skill simply means we have not yet acquired the ability to co-ordinate our faculties. Trying, in a "hit-or-miss" manner to force untrained faculties to co-ordinate is like trying to force a savage chieftain to read, write and act the part of a gentleman. That is why so many ambitious code students become so nervous that in many instances, under pressure, they collapse.

The foregoing is for the purpose of conveying to you that poor concentration, lack of receiving, writing and sending ability, inability to copy a few words behind, and make a clean, accurate copy, are effects, only. Trying to handle effects is futile. We must deal directly with fundamental causes. To overlook or ignore the functioning of the brain in telegraphing is a grave error. You telegraph with your brain. The hand that sends is merely a servant of your mind.

When your hand, for any reason, cannot execute the commands of the brain, the brain frets and worries. Your hand is passive—it does not think, hence it does not worry. It can be trained to co-ordinate with the brain and carry out its commands, but until it has been so trained its capabilities are extremely limited.

Science teaches us that the muscular system is an automatic living mechanism of the most complicated and wonderful kind. To every muscle arteries carry their vital streams of food and oxygen. The muscle cells select their own diet, and the veins (not the arteries) take away the waste products. Anything that interferes with this process interferes with the co-ordinative principle of your body and throws it out of gear. On every muscle there are the fine endings of some nerve which comes directly or indirectly from the spinal cord, and, at the proper moment, a discharge along the nerve causes the whole mass of cells or fibers in the muscle to contract simultaneously and lift the bone to which the muscle is attached. The nerve impulse is slight, merely like the match set to the great energy stored up like powder in the muscle.

Now apply this process to telegraphing—to sending, to receiving and writing with a pen or "mill." Anything that interferes with the normal functioning of a muscle, especially in the arm of the telegrapher, throws the entire muscular and nervous system out of balance.

The transmitting key should be placed on the table far enough in from the edge so that your arm will be supported comfortably by the muscles in the forearm. The key should be held loosely, but not squeezed, in a comfortable position so that the muscles will be able to obey the commandments of the nervous system including the brain. Then start in practicing sending the code from a newspaper or from a book, keeping in mind the spacing requirements that I have previously set forth. But be sure that you make your spacings exactly correct so that your future practice will teach you to transmit the code correctly rather than incorrectly. Practice makes perfect but bad habits in sending the code are just as hard to get rid of as any bad habit.

CANDLER SYSTEM

One of the finest short-wave activities, and one which will be of great interest and value to an enormous number of short-wave fans, "hams" and prospective "hams", is found in the series of code practice transmissions being put on the air regularly by members of the Candler System Code Guild for the benefit of all owners of short-wave receivers who desire to learn to read code, or to brush up in cases where former ability to read code has become rusty from lack of regular and steady practice.

With the constantly growing popularity of short-wave broadcast reception many former broadcast band fans have been brought down the wave bands into the realms of the amateur and the commercial stations. In tuning for short-wave broadcast stations, stations transmitting code are constantly being encountered and it is only human for the uninitiated listener to wonder what messages all the dots and dashes are conveying. Such curiosity is experienced by

everyone who hears code transmissions and in a great many cases is sufficiently all-consuming to drive the listener to learn the code and practice until he can read some of the code transmissions. In many other cases, however, the will and the desire to learn is there but not the patience required to learn to read code by practicing on regular commercial or amateur transmissions. To add to the difficulties of beginners, the commercial transmissions are usually too fast to be of any material use for practice purposes. The average amateur transmission is slower but unfortunately the slowest transmission is more likely than not coming from the key of some amateur who is just breaking into the game and whose sending is so poor that even an expert might have great difficulty in understanding it. This sort of transmission is therefore not of any possible use to one who is endeavoring to learn to read and transcribe code messages.

The Code Guild overcomes these handicaps, and its regular scheduled transmissions should be particularly useful not only to beginners, but likewise to the "old timers" whose code reading ability has suffered from lack of practice, and to those who can read moderately fast transmission but who wish to improve their speed either for their own satisfaction or perhaps in order to qualify for operators' licenses of higher grades.

According to one of the latest Guild schedules these practice code transmissions are put on the air every day in the week. Monday, for instance, there are transmission periods starting at 3:30, 8:00 and 9:15 p. m., C. S. T., put on the air by amateur stations in the Middle West. At 7:30 p. m. M. S. T., an amateur station in the Rocky Mountain section goes on the air. At 10:00 p. m., Pacific Time, a West Coast "ham" station starts up. These stations transmit at speed varying between 10 and 25 words per minute, each transmission including a variety of speeds within this or a somewhat narrower range.

Other days of the week the schedules include these as well as other hours, and also include other speeds, some as low as 5 and 8 words per minute and as high as 30 words per minute.

The operators of the amateur stations taking part in the transmission schedules are all highly qualified operators. All are men who have received their training in the Candler System, a scientific system of training which is widely known for the high degree of skill and precision among the operators it turns out. Walter H. Candler, the founder of the training course, was himself well known in the earlier days for his precise "fist" when working a transmitting key, and in his training system has demonstrated his ability to train others to duplicate his achievements.

No less an authority than T. R. McElroy, world's champion radio operator for three successive years, vouches for the perfection of the code transmission of the operators who send out the Code Guild practice transmissions. Replying to a letter of inquiry he writes: "I brushed the dust off my old short-wave receiver, when the Code Guild transmissions were called to my attention, and at 7:30 p. m., C. S. T., W9HML came through splendidly with perfect signals. Since then I have been listening in on the various Guild programs every night. ——I would have known, had I happened on to one of these programs accidently, that the operators are Candler trained.

One can never mistake those perfectly formed signals. They are music to my ears. So far I have copied the programs from six Guild stations and find little to differentiate between them, so far as perfection of operating ability is concerned."

It is an interesting commentary that Mr. McElroy is himself Candler trained.

The Candler System Code Guild is made up of graduates and undergraduates of the Candler System. It was started for the dual purpose of providing practice for its members and to improve the standards of transmission in general by enabling anyone interested to listen in on the transmissions, thus obtaining good practice and at the same time learning to appreciate good key operation and its advantages. Incidentally, there is no charge or obligation of any kind to those who wish to listen in. The programs are sent out over certain "ham" stations, operating in the regular amateur bands.

RADIO NEWS readers who desire to take advantage of these transmissions can obtain a copy of the transmission schedule in effect by addressing a request to "DX Corner," RADIO NEWS, and inclosing a self-addressed, stamped envelope. This schedule gives the hours, station call, frequency and type and speed of transmission for each scheduled program. Due to the use of short waves it is possible for a fan living anywhere in the United States to bring in a sufficient number of these programs to provide daily practice.

A copy of the current schedule is not published with this article because the schedules change somewhat from month to month and by the time this article appears in print the chances are the present schedule would be partially out of date. It is for this reason that arrangements have been made to furnish up-to-date schedules direct to readers who write for them. An activity such as this is one of the type which RADIO NEWS takes pleasure in encouraging and furthering because it is one which we feel sure will be not only of interest but of real utility to many readers.

Another type of transmission which provides good code practice material is found in the "press" copy sent out regularly by numerous short-wave commercial stations. A schedule covering the transmissions of approximately 50 of these stations has been compiled and will also be supplied without charge to those sending a stamped addressed envelope to the DX Corner. These "press" transmissions are keyed at various speeds and the schedule includes stations all over the world, the great majority of which could be picked up readily from any point in the United States by anyone equipped with a suitable short-wave receiver. Some of these transmissions are continuous wave and can be heard on receivers which include provision for c.w. reception. Others are modulated notes which can be received on a short-wave broadcast receiver.

AUTOMATIC CODE TRANSMITTERS

Automatic senders have come into use which served to insure perfect signals and to eliminate the necessity of having an operator present all the time. Yet, although these devices have been of great help, it was practically impossible to do away with hand-sent signals altogether. This made it necessary for students to attend a resident

course or to find someone who could send to them.

Some years ago Miller invented the Teleplex, which has become the most popular of the mechanical devices. This instrument still had the disadvantage that one was limited to the tapes which could be bought. The making of tapes required a rather complicated apparatus which is too expensive to be owned by the average student.

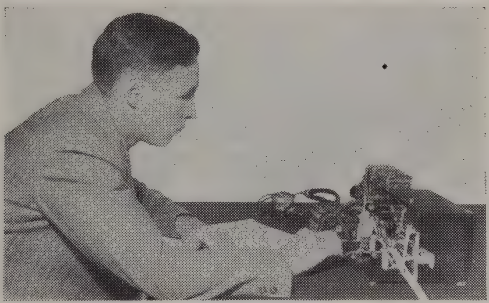


FIGURE 81

Now Miller has invented a new device, which he calls the Master Teleplex. See Figure 81. This instrument records the signals on a tape with a pen instead of perforations and the student can make his own tape as well as run them off with the same instrument.

The Master Teleplex, therefore, gives an unlimited variety of possible tapes, and it can be employed for the learning of sending as well as receiving. It is ideal for learning the code and every Boy Scout troop should own one.

The Master Teleplex contains a spring-driven mechanism which moves a paper tape at uniform speed past a pen. This pen normally rests on the middle of the tape. When the sending key is pressed, the pen is moved sideways by an electro-magnet. Before starting the recording of a message, the entire tape is run past the pen so that a single straight line is made at the center of the tape. Then the tape is ready to receive its message. The pen will retrace the previous line, but when the key is pressed the signals are formed.

The spring of the magnet and the distance can be so adjusted that it will follow the highest speeds an operator can send. We are told that a speed of 70 words per minute—delivered by a machine—was recorded perfectly.

But now comes the important part of the story. The ink used is a conductive compound. In "playing back," the tape is run under a set of two spring contacts; one of these runs over the steady line in the middle and the other covers the dots and dashes. It is easily seen that a contact is made every time a dot or dash passes under this second spring. When the two contacts are thus connected they close the circuit of an oscillator and the dots and dashes can be heard in the headphones. The diagram of this oscillator is reproduced in Figure 82. The clockwork, key, electromagnet and pen, as well as the oscillator, are included in the unit. The entire instrument

is a compact unit made entirely of metal, as can be seen in the illustrations.

The speed of the tap is adjustable within rather wide limits; this enables the operator to run the machine at the desired speed. While receiving, the tape is rolled up on a second reel. Now, in order to use the tape again it would have to be rewound, but here another novel idea comes in. Another message can be recorded on the same tape by having the pen move sideways toward the other side of the line. Rather than reversing the movement of the pen, the tape is reversed. This means that when once the tape has been used and wound on another reel, it is at once ready for the copying of the second message without rewinding. The same thing can be repeated on the reverse side of the paper, making, in all, four times that the paper can be used for recording.

In practice, mechanically perfect sending is seldom encountered on the air—unfortunately. The student who has learned his copying from mechanically perfect devices is going to encounter difficulties when receiving on the air. This device, however, records signals *as they are actually sent*, and the student will become used to the average type of signal.

Contrary to popular opinion, learning to send is far more difficult than learning to receive. This new device provides an excellent way for the student to test his own sending. Various charts showing good, fair and poor sending are furnished with the new

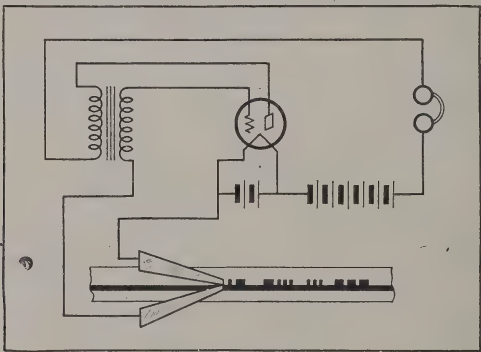


FIGURE 82

Teleplex so that the student may easily and quickly compare his sending. For the beginner, mechanically perfect records are furnished by the makers of the device, enabling the student to get started in the proper manner. As he advances he can make his own tapes. After the student is able to make readable signals, he submits a specimen to the company, and he will be furnished with the addresses of other students owning the Master Teleplex so that they can exchange their tapes. In this way there is no limit to the variety of exercises available. The student can inspect his own signals by looking at the regularity of the lengths of dots, dashes and spaces or he can run it off and listen to the signals.

A few practical pointers on this recording will not be amiss. The ink furnished with the device is a special preparation which contains a metal compound and dries quickly. As you will notice in the picture which illustrates the use of the Master Teleplex when recording, the tape is then left trailing off the table. During the time it takes the paper to advance from the pen to the floor, the ink has dried. The paper cannot be wound on the reel immediately because this would blot the signals.

Ink is fed from an inkwell to the pen by a wick. The height of the inkwell is variable so as to regulate the flow of the ink. Further, the pen arm must be adjusted so as not to strike the magnet too hard, for that would throw the ink from the pen.

Not only beginners, but experienced operators, experimenters and amateurs will find many new uses for the Master Teleplex. A sensitive relay is available which will operate the recorder from a receiver. Messages taken from the air may be recorded and later copied at a slower speed. Also, if the operator happens not to be present during the sending of press, the message can be recorded and transcribed later.

The amateur can record the signals received from his friends or correspondents and show them how they are sending. Another use for the amateur is to record a call or a CQ on a tape and paste the ends together. The headphone can be held near a small microphone and thus he can modulate his transmitter automatically. Messages can be recorded on a tape previous to their transmission and this tape could then be run off at any desired speed when the desired party has been contacted on the air.

MORSE TELEGRAPHY BY RADIO

In copying code I favor a standard telegraph sounder in preference to the orthodox method of continuous wave telegraph reception by radio. The system outlined here makes it possible to reproduce standard c.w. signals from amateur and other stations on a standard land-line sounder, or a printing recorder. The equipment outlined here will operate in connection with standard short-wave regenerative or other receivers using three or more tubes.

The circuit is shown in the diagram, Figure 83. Two –12A type tubes are used, the filaments of which may be operated from the receiver storage battery if a d.c. filament job is used. If an a.c. receiver is used heater type tubes are advisable and may in some cases be run from the a.c. filament supply of the receiver.

The first amplifier stage has a tuned input which is peaked at approximately 1000 cycles. L1 is the secondary of a Ford spark coil of the model T vintage, having both the core and the primary removed. The value of capacity across the coil may be varied within small limits. T1 is a standard audio transformer which delivers excitation to the Class B second stage. When a signal is applied to the input of the unit a strong exciting voltage appears on the grid circuit of the Class B amplifier which causes plate current to flow through the relay in the tube's output circuit. The closing of the relay circuit then causes the local battery circuit to close, operating a sounder or other device. The relay is of the type designed

to work out of vacuum tube circuit, is very sensitive and may be purchased on the market.

A Class B amplifier is defined as one whose power output is proportional to the square of the exciting voltage on the grid and

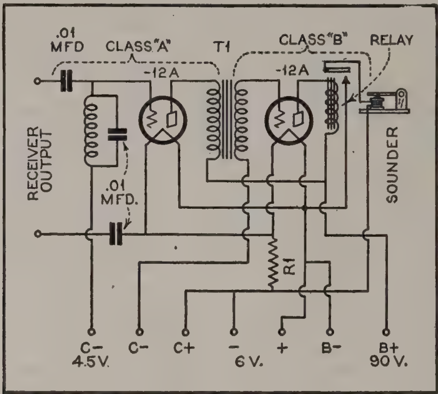


FIGURE 83

has a grid biasing voltage sufficient to reduce the plate current almost to zero with no excitation voltage in the grid circuit. In the case of this Class B tube circuit the bias voltage may be arrived at by increasing it in small steps until the relay just opens the local battery circuit.

With some radio receivers troublesome feedback may be had when the additional amplification of this two tube unit is present. Such a feedback is usually caused by insufficient shielding and the lack of audio bypass or filter circuits in the receiver. In some cases isolating the unit a short distance from the receiver may be sufficient to eliminate the feedback trouble. In other cases a reduction in the gain or redesign of the audio amplifier will be necessary.

A PENTODE CODE PRACTICE SET

The simple audio-frequency oscillator shown in the accompanying photo and circuit uses a type –34 r.f. pentode instead of a –33, because the –34 draws only about one-fourth as much filament current as the –33. A single 1½-volt flashlight cell of the large size is used for lighting the filament and two 3-volt flashlight batteries for the B supply.

Very few parts are needed to build this code practise oscillator. See Figures 84 and 85. All components are mounted on a wooden chassis. The A battery clips, tube and transformer are mounted on top of the chassis, also the grid leak, while the B batteries are mounted underneath, held in place by clips at each end. The chassis made of thin stock similar to cigar box wood is 4½ inches long, 3¼ inches wide and 1½ inches deep. The transformer may be almost

any type having a center-tapped winding. A push-pull input transformer taken from an old Radiola X is used in this oscillator. The primary is not used and the terminals are left open.

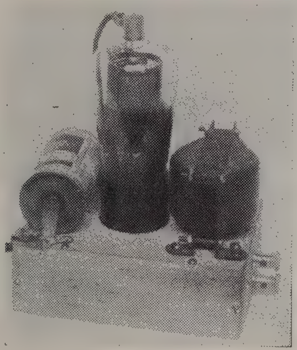
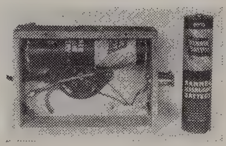


FIGURE 84—LEFT.

FIGURE 85—BELOW.



A four-prong socket is needed for the –34 tube. See Figure 86. The A battery is held in place by two pieces of phosphor-bronze taken from an old tube socket. Two small Fahnestock clips are pro-

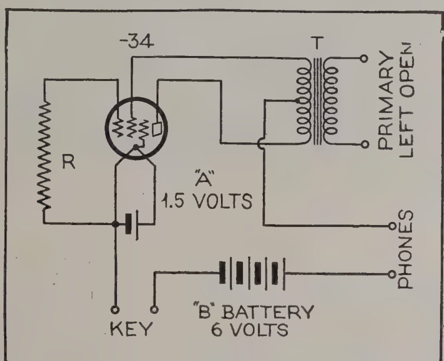


FIGURE 86

vided so that an external A battery may be used when desired. The B battery clips are made from the same materials as the A battery clips.

The value of the grid leak is not critical. It may vary from ½ to several megohms. The higher the resistance of the leak, the higher the tone of the oscillator. In this oscillator the grid leak may be left out and the control grid left entirely unconnected. Try this; it raises the tone of the oscillator.

CHAPTER 10

Amateur Transmitters

MOST amateur transmitting equipment is designed with low cost as the primary consideration. True, efficiency comes in for a good share of attention, but is likely to be sacrificed at points to keep costs low. In designing a new transmitter for use in experimental transmission work it is felt that the builder should strive for efficiency above all else, keeping costs down at the same time to the minimum required for best operating results. It is felt that a transmitter such as this will be of intense interest to a great many amateurs who now have low-power transmitters, but who have gone far enough in the game to feel the need of greater power and more careful design.

The beginner in the transmitting end of radio has always been urged to start with a low powered 210 transmitter. This practice is to be commended. It benefits the beginner inasmuch as it eliminates the possibilities of damage being done to expensive equipment and other things which can happen when inexperienced hands are used. It is a boon to the transmitting fraternity in general since it does

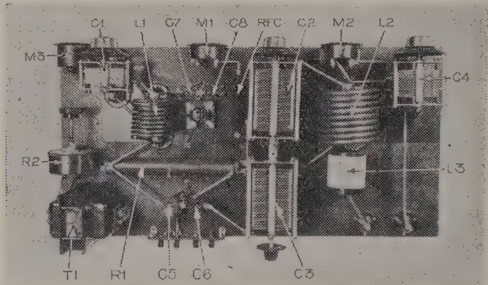


FIGURE 87

away with high-power signals which are liable to cause excessive interference while the beginner is learning the rudiments of operating.

Some really good work has and is being done with the "Seven and a half watter." Twenty meters with its penchant for carrying low-power signals has rewarded many with long distant two-way communications. But the results are far too inconsistent with the conditions now prevalent. The amateur bands are crowded and fair power is needed for reliable work. The transmitter being described is an ideal one for those who have received a working knowledge of low power work as well as those who are contemplating a new, medium powered outfit.

We have, first, to consider the choice of the oscillator tube. Many amateurs that have been contacted seem to be of the opinion that the 50-watt is a much better tube to use than its larger brother, the 552. This, in practical experience, has been found to be untrue.

The 552 type tube, with its irregular shape and low capacity arrangement of leads has been found to make for much better connections in a transmitter where short leads are desirable. The 50-watt type tube necessitates the use of a socket where all leads are bunched. The t-g-t-p circuit is not easily adaptable to a 50-watter or even to a 210. Disregarding the physical make-up of the 552, its internal construction is such as to leave little desired for all around amateur purposes. Its low internal capacity makes it the ideal thing for the 14 megacycle band as it does on the 7 megacycle band. On 3.5 or 1.7 megacycles, the tube is found to be as near perfect as wanted.

Another point which concerns the tube is the power to be used on it. It seems to be a general belief that where a tube of this type is used, 2000 volts must be put on its plate. In practical experience it has been found that voltages between 1000 and 1500 showed no appreciable decrease in signal strength over the 2000-volt power. Reports from reliable stations contacted showed that the signal received when using but 1000 volts on the plate was better than when using 2000 volts because the lower power signal was more clean-cut and consistent. Then again a better d.c. note can be procured from a tube which is being under-run in power than when the rated voltage is used.

The writer has also found that a self-excited oscillator works best when the least current is drawn by the plate of the tube for a given plate voltage. The oscillator being described should draw no more than 90 milliamperes when the antenna is connected, and using 1000 volts on the plate. With the antenna, a drain of from 30 to 40 milliamperes should be expected.

Most of the equipment is mounted on General Radio stand-off insulators. See Figure 87. This provides a minimum of loss and keeps the apparatus out in the open. Another feature of using these insulators is that they bring the coils and variable condensers up near the leads on the tube and thereby shorten these leads.

Two Cardwell transmitting condensers, type T–199, each having a total capacity of .00033 mfd.. are placed in parallel (C2, C3) to provide the high capacity necessary for the "high c" tank circuit. See Figure 88. These condensers are the double spaced type and will safely stand the voltage encountered here. A .0005 mfd. receiving condenser is used in the grid tank since a transmitting condenser of the double spaced type is not necessary in this circuit. A cardwell transmitting condenser, type 164–B with a maximum capacity of .00022 mfd., C4, is used in the antenna feed wire proper.

Both the grid and plate stopping condensers, C5 and C6, are fixed condensers, with a voltage rating of 5000 to provide an ample safety factor. The two filament bypass condensers, C7 and C8, are placed as near to the tube socket as possible. This eliminates a considerable amount of sparking at the key.

The filament transformer, T, is placed on the top shelf to eliminate long filament leads. A variable filament control, having a resistance of from ¼ to 10 ohms is used (R2) to keep the filament voltage on the tube at approximately 9.5 volts. This can be checked on the O-15 a.c. voltmeter, M3, which is an essential part of the transmitter and assures long life for the tube.

The 10,000 ohm transmitting grid leak, R1, must have a wattage

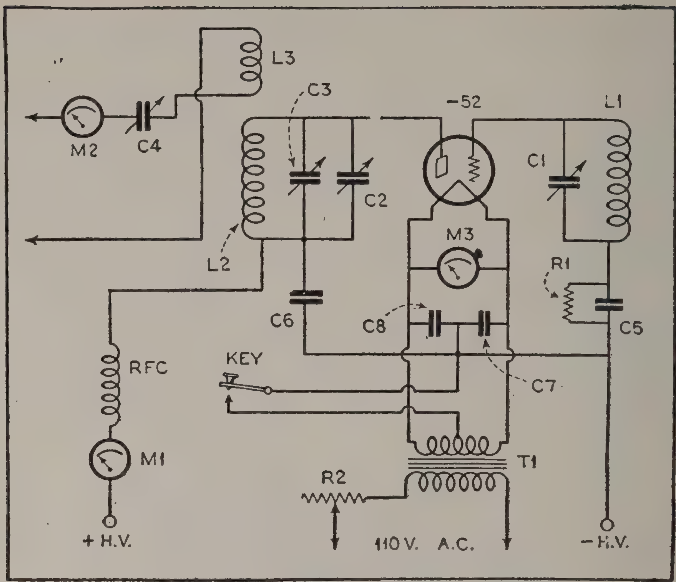


FIGURE 88

rating of 100 if excessive over-heating is to be avoided. An over-heated grid leak will cause the signals to "creep" and makes for unsteadiness.

The radio-frequency choke coil, RFC, can be constructed by winding 160 turns of 26 gauge d.c.c. wire on a ¾ inch diameter form. This choke is not very critical at this point. Any commercial r.f. choke designed for use with this tube can be used, if desired.

The coils are hand wound, using pieces of iron pipe as the temporary winding forms. Soft drawn copper tubing is used. Care should be taken in winding since copper tubing has a tendency of flattening out if bent sharply. Turns need not be spaced while winding. The edge of a screw driver can later be used to separate them. When the coils are completed the two ends of each coil are flattened and drilled to fit over the screws on the stand-off insulators.

The accompanying table should be followed very closely if the right frequencies are to be covered. The antenna coil, L3, is wound on a bakelite form with a diameter of 2½ inches. The form should be approximately 3½ inches long. 25 turns of No. 14 d.c.c. wire are used, with no spacing between the turns. A hole, large enough to fit over the screw in a stand-off insulator is made in one end of the tubing. With the coil mounted as shown in the photographs, it can be swung from side to side to vary the antenna coupling.

Regarding the antenna coil, it has been found that, by coupling a Hertz or Zeppelin antenna directly to the plate coil, approximately the same current is produced in the antenna. This method of an-

tenna coupling does not, however, give as good a tone or as sharp a signal. The 25 turn antenna coil will be found to work best with almost any type of antenna system.

In wiring the transmitter, it must be remembered that the tank circuits are subject to a high current load. Poor soldering work or hook-up wire which is not heavy enough will impair the operation of the circuit. A No. 10 wire should be the smallest used, with two

Band		Copper Tubing Outside diam.	Inside Diam. Coil	Number of Turns
3500 k.c	plate coil L2	3/8 inch	3 1/2 inches	nine
	grid coil L1	1/4 "	2 3/8 "	thirteen
7000 k.c.	plate coil L2	3/8 "	2 3/8 "	five
	grid coil L1	1/4 "	2 3/8 "	five
14000 k.c.	plate coil L2	3/8 "	2 3/8 "	two
	grid coil L1	1/4 "	2 3/8 "	two
28000 k.c	plate coil L2	3/8 "	2 3/8 "	one
	grid coil L1	1/4	2 3/8 "	one

FIGURE 89

of these wires twisted together to be used in connecting the coils to the variable condensers and to their respective circuits. Quarter inch copper tubing is ideal for r.f. connections and was employed in the model shown in the photographs.

Again stressing the need for short leads, one must be cautioned against the use of right-angle leads. It must be remembered that it is better to have a transmitter that works well rather than one that is prettied up with tricky wiring.

The List of Parts

C1, Caldwell type 123-B receiving condenser, max. cap. 500 mmfds.
C2, C3, Cardwell type T-199 transmitting condensers, max. cap. 330 mmfds.
C4, Cardwell type 164–B transmitting condenser, max. cap. 220 mmfds.
C5, Aerovox .00025 mfd. fixed mica transmitting condenser, 5000 volt breakdown.
C6, Aerovox .002 mfd. fixed mica transmitting condenser, 5000-volt breakdown.
C7, C8 Aerovox, .002 mfd. mica fixed receiving type condensers.
L1, L2, L3, 9 transmitting coils, (see text).
M1, Weston model 301 P.D.C. plate milliammeter 0–300 mil. range.
M2, Weston model 425 R.F. Thermo-Ammeter, 0–3 amp. range.
M3, Weston model 476 A.C. Filament voltmeter, 0–15 volt range.
R1, Electrad 10,000 ohm center-tapped grid leak, 100 watts rating, mounted.
R2, Clarostat super power filament control.
RFC Radio frequency choke coil (see text).
T1, Thordarson type T–2383 12 volt filament transformer, 175 watts.
1 Air gap UX tube socket .
1 DeForest type 552 transmitting tube.
14 General Radio stand-off insulators.

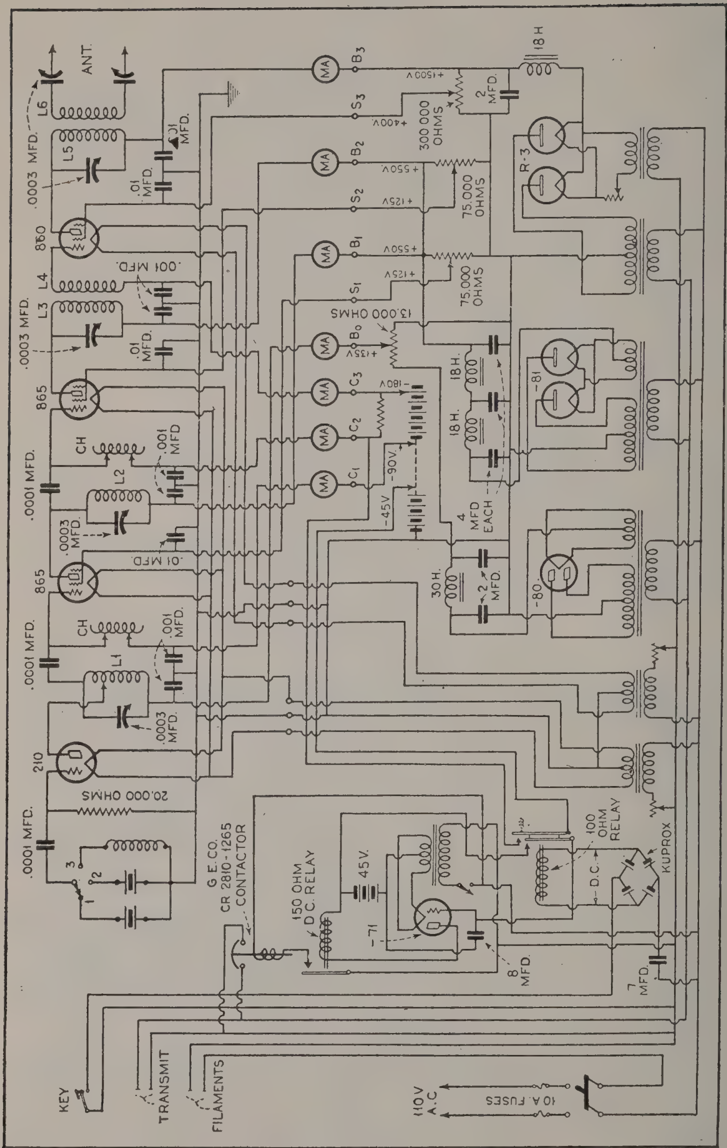

ANT.
L6
.0003 MFD.
L5
.01 MFD.
.01 MFD.
860
L4
.001 MFD.
L3
.0003 MFD.
.01 MFD.
865
CH
.001 MFD
L2
.0001 MFD.
.0003 MFD.
.01 MFD.
865
CH
.001 MFD.
L1
.0001 MFD.
.0003 MFD.
210
20,000 OHMS
.0001 MFD.
1
2
3
G.E.CO.
CR 2810-1265
CONTACTOR
150 OHM
D.C. RELAY
45 V.
-71
8 MFD.
7 MFD.
100 OHM RELAY
D.C.
KUPROX
KEY
TRANSMIT
FILAMENTS
110 V A.C.
10 A. FUSES
MA
B3
S3
B2
S2
B1
S1
B0
C3
C2
C1
+1500V
+400V
+550V.
+125V
+550V
+125V
+135V
-180V
-90V.
-45V
300,000 OHMS
75,000 OHMS
75,000 OHMS
13,000 OHMS
2 MFD.
18 H
R-3
18 H.
18 H.
4 MFD EACH
-81
30 H.
2 MFD.
-80

FIGURE 90

1 Bakelite knob.
3 4-inch Bakelite dials.
1 Binding post strip with 6 Eby posts.
Assorted hook-up wire or copper tubing, hardware, misc.

A CRYSTAL-CONTROL TRANSMITTER

In the design of a truly modern transmitter there are many factors that cannot be overlooked. These may be considered in three groups: (a) The emitted signal must comply with the Federal Radio Regulations. (b) The transmitter must be of sufficient power and stability to permit reliable communication. Three-band operation is also desirable. (c) The cost of the component parts must not be unreasonably high.

In order to fulfill the first requirement, the emitted signal must be within the allotted frequency bands and must be of single frequency. That is, the unmodulated carrier must be "pure d.c." in quality and have little or no drift. The keying should be reduced to a minimum for the benefit of the neighbors. From the above specifications it is obvious that some type of master oscillator must be used.

For reliable communication at least fifty watts in the antenna should be used. Of course, two or even one type 210 can be urged to give this output, but this is far from good practice. Stable operation can be obtained only when the component parts of the transmitter are run below, or very near, their rated power. If operation in several bands is desired, more than one stage of amplification will have to be used.

The complete circuit is shown in Figure 90.

The crystal oscillator uses a type 210 and is arranged so that one of three quartz crystals or resonant chokes may be selected. The first amplifier employs a type 865 tube, and is capacitively coupled to the oscillator. The second amplifier is similar to the first. The power stage employs a type 860, seventy-five-watt tube. Unlike the other stages, it is inductively coupled to its exciting amplifier. The antenna is inductively coupled, but may be capacitively coupled if so desired. The foregoing is a general outline of the transmitter proper.

The oscillator employs the simplest possible circuit, with no frills or unnecessary trimmings. It was found advisable to arrange the apparatus so that the crystals could be mounted outside the cabinet, as the heat of the tubes had a tendency to change the frequency of the quartz crystal.

USING METERS IN ADJUSTING THE TRANSMITTER

Most amateur transmitters contain at least one stage of r.f. amplification—the power amplifier—following some type of master oscillator, either crystal or self-controlled. The better transmitters (especially in phone work, where it is very advisable) use a buffer amplifier between the oscillator and power amplifier to prevent frequency variation due to a varying load on the oscillator. The buffer stage also permits the oscillator to be run at a light load, which

is a particular advantage when using crystal control, as the temperature rise of the crystal with its consequent frequency drift will be reduced. Where high power is used, an additional stage may be necessary to bring the r.f. voltage up to a proper level for exciting the power stage. These are all straight r. f. amplifiers which are called upon to amplify not only r.f. voltage but also r.f. power. Unlike audio (Class A) amplifiers, the r.f. (Class B) amplifier grid draws current and, therefore, takes power to excite it.

Straight r.f. amplification of one frequency in transmitters has a great deal in common with r.f. amplification in receivers. Each stage must be neutralized unless screen-grid tubes are used, and even then it is sometimes desirable to neutralize the control grid-plate capacity to improve stability. When improperly neutralized or not carefully designed, the amplifier stages are inclined to oscillate, exactly as in receivers. This must be carefully guarded against, for when an amplifier oscillates it is usually on some frequency other than that of the master oscillator—and it is a very serious offense for a transmitter to be off its assigned frequency.

Tubes used as radio-frequency amplifiers are usually operated as Class B stages. This type of amplifier operates with a high grid bias such that, when there is no excitation, the plate current is practically zero. The reason for using Class B amplifiers in place of the more familiar Class A or audio amplifiers is that the efficiency of a Class A amplifier is only around 15%, while 80 to 85% efficiency is obtainable from a Class B stage.

For efficient operation with normal output it is imperative that the amplifier be given sufficient excitation from the preceding stage.

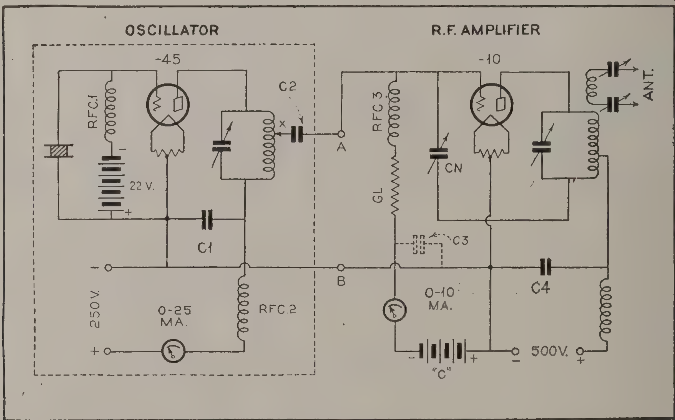


FIGURE 93

Screen-grid and pentode tubes require somewhat less r.f. power to operate them than do the more familiar triodes and are, therefore, to be preferred. For the present we will consider the operation of r.f. amplifiers from the theoretical viewpoint, to become familiar

with some of the working tools of the engineer and experimenter and to be "all set" to find out the whys and the wherefores of the practical arrangements that follow. For the beginner or the non-technical amateur or experimenter, read the following discussion through carefully.

Let us first consult Figure 93, where, for the purpose of discussion, we will consider the simple transmitter consisting of a type –45 crystal oscillator feeding a type –10 power amplifier—a very reasonable low-power arrangement. The r.f. output from the oscillator is fed through the coupling condenser, C2, via the feeders A and B to the input circuit of our amplifier. This constitutes a shunt-feed arrangement where the choke, RFC3, has practically the entire r.f. input voltage across it. This choke, therefore, must be a good one, or some of the precious input voltage will be shunted into the "C" battery circuit, which, besides being a loss, may cause a great deal of trouble by being coupled into other circuits, especially where the same source of grid bias is used for other tubes as well. As a precaution, we could add a mica by-pass condenser (C3) to offer a low-impedance path to filament to any radio-frequency currents getting through the choke, thereby keeping it from the source of "C" supply. If, on adding this condenser, a change in plate or grid current resulted, it would prove that RFC3 was *not* an effective choke. If, on the other hand, no change of any kind was noticed, the chances are that the choke is O.K. Unforeseen troubles, such as this type of feedback, often make it difficult—and sometimes make it impossible—to neutralize the amplifier. This is fortunate, for a disease with clear symptoms is the easiest to diagnose—and cure! But let us continue our story about the grid or input circuit of the amplifier. Note, in Figure 93, the grid milliammeter which is connected in series with the "C" battery.

This meter is a valuable indicator, for when the amplifier and the oscillator are turned on, the meter will indicate relative values of exciting voltage. In other words, it will act as an r.f voltmeter and will be very useful in neutralizing the amplifier and in getting optimum output from the oscillator. The unidirectional current that operates this d.c. milliammeter comes from the r.f. exciting voltage which is rectified by the grid of the amplifier. In other words, the meter reads "rectified r.f. current." This is one of the most important points that must be grasped if one is to really understand the operation of r.f. amplifiers. In view of this, let us pause a moment to consider the various parts of Figure 94. As we are considering Class B amplifiers just now, no plate current is flowing (and, of course, no grid current) when there is no excitation. Let us turn on the oscillator and couple the amplifier very loosely. This will give us a very small exciting voltage which (a) is supposed to represent. A little plate current will now flow, but there will be no grid current, because we still have ample grid bias. (In order that appreciable grid current may flow, the grid must go positive—that is, the r.f. input voltage must exceed the "C" bias.) The curve (b) pictures the condition where the input voltage peaks are just equal to the bias voltage. This is the point at which grid current just begins to flow. With still closer coupling, we get the condition shown at (c), where the exciting voltage exceeds the "C" bias, and grid current

flows during a small part of the cycle (shown shaded. Plate current flows during the entire half cycle). Now the grid, in drawing current from the exciting voltage, raises itself (from a d.c. standpoint) above the "C" bias potential so that, during that part of the cycle where the grid is positive with respect to the filament center-tap, pulses of current are sent into the "C" bias circuit. In other words, the grid actually charges the bias battery and the grid millammeter reads the rate of charge! Maybe it will be more obvious if we picture it in another way, shown at (d). Let V_{rf} be our exciting voltage (it does not have to be a sine wave) which we will feed through the coupling condenser, C2, into our amplifier. When the "top side" of our r.f. generator is positive—as is shown—the grid will draw current if the peak voltage exceeds the grid bias. This current is pictured by the large arrows. None of this r.f. will be shunted into the "C" bias circuit, because the choke, RFC3, presents an infinite impedance to it. If any did get through the choke, the d.c. meter would not indicate it. Now, during that part of the cycle when the grid potential is higher than the "C" bias, a charging current will flow into the "C" battery as already stated. This current, which is represented by the small arrows, is that which the milliammeter records and is what we will refer to as the "grid current."

It is now easy to see that, if we insert a resistance in the "C" circuit, there will be a voltage drop across it equal to R1 (the resistance, in ohms, times the current, in amperes, through it). Such a resistor is called a "grid leak" and is included in Figure 93—marked GL. In installations where the "C" voltage is limited it is economical and sensible to use a grid leak to help supply the bias. It is impossible, however, to get true Class B operation, with its consequent high efficiency, with a grid leak alone. Some "C" voltage must be supplied externally. When using a grid leak, however, the plate current will not drop to zero when the excitation is removed, because the resistor cannot contribute any bias when there is no current flowing through it! The question now comes up—how are we going to know when we have the proper amount of resistance for Class B operation? The answer is simple; and this is a beautiful case in which the man who knows a little theory triumphs over the man "who is just an operator."

$$\text{Class B bias} = \frac{E_b}{\mu}$$

where E_b is the plate voltage and μ the amplification constant of the tube (which is given in the tube data sheets). This is the total bias. Knowing how much actual voltage we have available, the remainder must be supplied by the grid leak which is calculated from Ohm's law—

$$R = \frac{E}{I}$$

where I is the current given by our grid milliammeter. In a number of tests run at W2BRB with various tubes, the value of the grid current ranged from $^1/_{10}$ to $^1/_{30}$ of the plate current. The actual value of the grid leak is not critical. A good plan might be to use any available resistance, calculate the drop across it and see how it checks with the desired bias. A vacuum-tube voltmeter—many have been de-

scribed in Radio News—would come in handy here in measuring bias voltages.

In connection with the foregoing calculation of grid bias, the author has found that, when using tubes as Class B r.f. amplifiers, the given value of μ is too high, so that it is usually necessary to add about 10% to the calculated bias to get complete "cut-off" (μ, the amplification constant, actually varies considerably with different grid and plate voltages and different plate loads).

So far, our discussion has centered on the grid circuit of the amplifier and, more especially, on the grid milliammeter itself. We are now ready to proceed to the next step, which is neutralizing. Here the grid meter plays a very important part.

NEUTRALIZING

When our oscillator is functioning properly and our grid meter shows the presence of r.f. in the amplifier stage, the first logical step is to neutralize the amplifier. Starting with the neutralizing condenser at minimum capacity, we tune the amplifier plate condenser until a dip occurs in the grid current. This indicates that the plate circuit is tuned to the oscillator frequency and, furthermore, that the tank (plate) circuit is drawing power, assuring us that the amplifier is *not* neutralized. As these phenomena are important, we will pause a moment to picture the happenings just referred to.

Figure 95 at (a) shows how the amplifier tank-circuit is coupled to the oscillator through the condenser formed by the tube's grid and plate (C_{g-p}). When the tank is tuned to resonance with the oscillator, it absorbs some energy, which causes a lowering of the grid potential and, therefore, a dip in the grid current. Now if we add a neutralizing condenser and split the plate coil as in (b), we can prevent the plate tank from absorbing any energy by balancing the circuit formed by C_{g-p} and the top half of the plate coil, with the circuit formed by the bottom half of the plate coil and the neutralizing condenser. The arrows picture a current coming from the source of radio frequency, splitting into the two branches just mentioned, and balancing each other so as to cancel in the tank coil. This is the principle of one method of neutralizing. The plate coil need not be tapped in the center. All that is necessary is that the number of

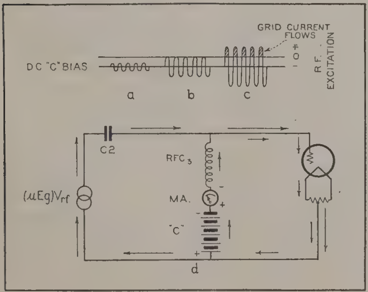
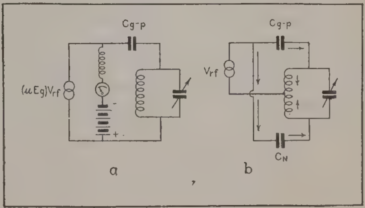


FIGURE 94—LEFT.

FIGURE 95—BELOW.



turns used, with a given capacity neutralizing condenser, be sufficient to balance the voltage arriving in the plate circuit through the grid-plate capacity. The fewer neutralizing turns used, the larger the neutralizing condenser must be—and the greater loading effect the condenser will have on the oscillator tank circuit, as will be subsequently explained.

Now to go on with the process of neutralizing—we must turn on the amplifier tube so that it can draw a load, and we must disconnect the plate voltage to prevent self-oscillation with its dangerous feed-back. Now we start increasing the neutralizing capacity with one hand while we swing the plate condenser through resonance with the other, stopping every few seconds to readjust the oscillator plate condenser so that the r.f. input will not drop off. We should notice the resonance dip gradually diminishing until, at some point on the neutralizing condenser, there should be no dip at all. This is the point of neutralization. To prove that neutralization is really accomplished, we might further increase the neutralizing capacity whereupon the dip should return when we tune the tank circuit to resonance. It frequently happens that the point of what seems to be neutralization will be maximum capacity of the neutralizing condenser which shows us that we either need a larger condenser or, what is usually more reasonable, *more* neutralizing turns on the plate inductance. Then, again, the point nearest neutralization might be the point of minimum neutralizing capacity, which shows we need *less* neutralizing turns. Since the neutralizing condenser is effectively in parallel with the oscillator tank condenser, it may happen that, as we add neutralizing capacity, we get to a point where the oscillator tank condenser is at minimum capacity and will not tune, causing our r.f. input to drop off. This must be answered by removing a few turns from the oscillator inductance. During this process of neutralization it is well to reduce the "C" bias enough to permit full-scale reading on the grid milliammeter so that it will be easy to see the dip. Many amateurs and experimenters balk at the very word of "neutralizing," which is really foolish, seeing how easily it can be accomplished by the foregoing method. Many of the small, cheap voltmeters have a low resistance and a full-scale reading of 8 to 30 milliamperes, which makes it possible to use them for grid milliammeters. Their resistance will act as a grid leak, contributing to the bias as previously explained.

CHAPTER 11

Transmitters and Receivers for the Ultra-Short Waves

WHILE occupancy of the ten-meter band is by no means new, until lately there have not been many hams down there, because they did not understand its usefulness. It is good for short hauls, local traffic and rag-chewing and for extreme distances. It also lends itself admirably to beam transmission experiments. The short antenna used can be erected inside most rooms and reflectors can likewise be set up easily.

This antenna system, shown in Figure 96, erected inside the house, offers to the beginner an invaluable opportunity to learn the workings of an antenna system. A neon lamp, held in the hand and run along the feeders and antenna will show the distribution of r.f.

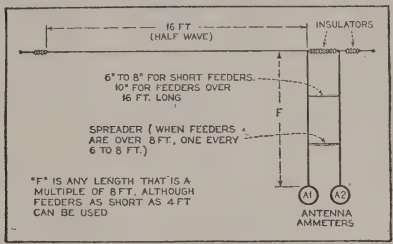


FIGURE 96

voltage in the antenna and feeders. When the system is properly tuned the lamp will light brightly at the two ends and gradually diminish as you work toward the center of the antenna and as you go down the feeders toward the set. (If you were to insert flashlight lamps every foot or so along the antenna and neon lamps every foot or so along the antenna and neon lamps between them, the flashlights would show the current distribution and the neon lamps the voltage distribution.) Of course, with a full-wave antenna (32 feet long) you would find two nodes (where the neon does not light). We recommend that beginners build this set in order that they may learn more about the way their antenna system works. The same rules hold true for the lower frequencies but are not as easily demonstrated.

The transmitter, the circuit of which appears in Figure 97, is a conventional tuned-grid-tuned plate, push-pull rig. In building it you must be careful to use rigid assembly methods and rigid wiring. The high frequencies are very susceptible to small changes in capacity that would be caused by loose, sloppy wiring. The r.f. leads should be kept wide apart to minimize the capacity between them. In the set which is shown in Figure 98 you will notice that r.f. leads, except those from the antenna coil to the antenna binding posts, are of bus bar, run as straight as possible.

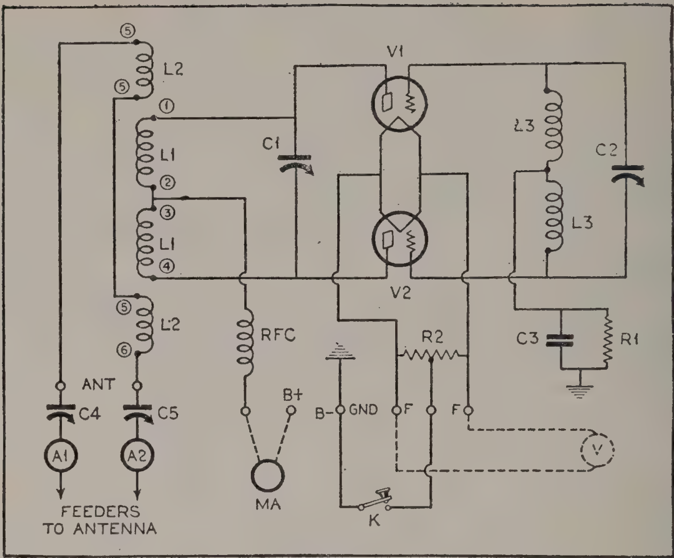


FIGURE 97

Parts for the Transmitter

L1—REL coil form (wound), No. 262-D special, and base
L2—(Wound on same form)
L3—REL grid coil, No. 262-D special and base .... $ 3.50

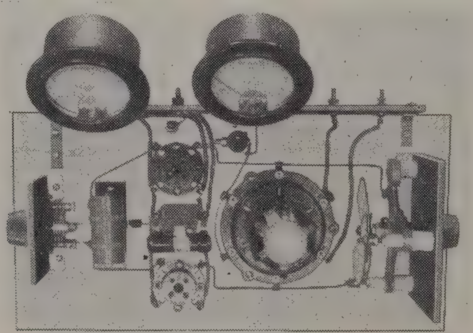


FIGURE 98

C1—REL variable condenser, No. 181-A special	4.00
C2—Pilot seven-plate midget	.45
C3—Illini .002 fixed condenser (1000-volt)	.20

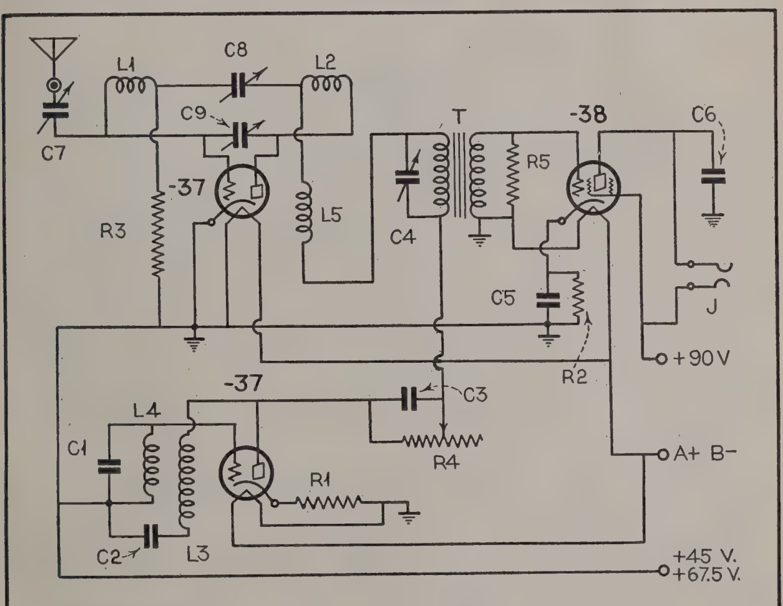
R1—10,000-ohm resistor .... .50
RFC—REL No. 132 r.f. choke.................................. 1.00
2 sockets, UX type .... .40
1 piece bakelite 3 inches square
1 piece bakelite 4½ inches square
1 piece bakelite 1½ inches by 12 inches (cut from scrap panel)
Wood screws, machine screws, washers, copper, etc............ .15

Total approx. $10.00
Keyed parts not included in costs:
C4, C5—250-mmfd. National condensers
K—Key
V1, V2—Tubes
A1, A2—Jewell 0-2.5 r.f. ammeters
MA—Jewell 0-50 or 0-200 milliammeter (depends on type and power of tubes used)
V—Filament voltmeter (optional)
R2—Center-tap resistor if no tap available on filament transformer.

A 5-METER RECEIVER

The transmission and reception of radio signals at frequencies in the order of 56 megacycles or higher has long been the subject matter of discussion and experimenting, so that the comparative merits of

FIGURE 100



such high frequencies and their possibilities for communication are now familiar to most experimenters. Particularly the 56-megacycle region, to which we will refer as the 5-meter band and which is open for amateur experimenting, offers a great fascination, not only to the licensed transmitting amateur, but also to other experimenters who wish to listen in.

While it is apparent that no extravagant claims may be made as regards the DX possibilities of the 5-meter band, these possibilities being particularly limited by geological and physical factors, there is

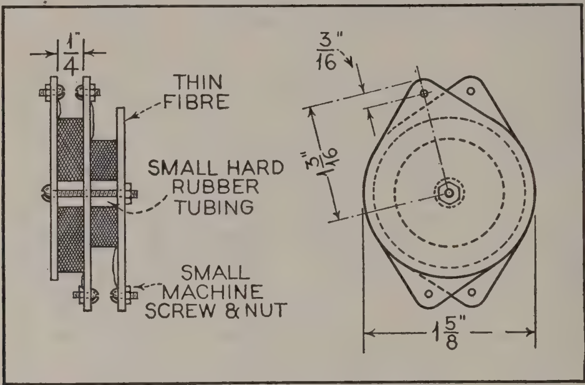


FIGURE 101

little doubt but that for local communication this wave range is highly practical—so much so that it is actually being put into broadcast service in field work, where metallic circuit facilities are limited or not available.

Work on these ultra-low waves offers some interesting advantages found in none of the higher wave ranges. There is a complete absence of atmospheric "static" and almost as complete absence of static of the man-made variety. In locations where wavelengths between 15 and 200 meters are practically useless because of interference caused by automobiles, power lines, household devices, etc., 5-meter reception will be notable for its quietness. Likewise, at times when broadcast-band reception is well-nigh ruined by atmospherics, not the least of this trouble will be found on 5 meters. Fading is also conspicuous for its absence on 5 meters. This means not only constant signals, but also the absence of distortion so commonly encountered on higher waves as the result of fading phenomena.

The 5-meter receiver we present herewith is intended to give the 5-meter enthusiast an inexpensive but highly efficient unit. Its circuit components embody principles long applied to receivers of many types, and while no claim is made of extraordinary novel circuit design, the general get-up of the outfit has proven completely worthy of whatever time and money is spent on its construction, because results have proved to be very gratifying.

The circuit shown in Figure 100 comprises a simple regenerative

detector using a type –37 tube, an auxiliary low-frequency oscillator using also a type –37 tube and finally a simple pentode audio stage using a type –38 tube, which for all purposes provides sufficient amplification for moderately strong signals to be received on a loudspeaker.

The receiver is of the well-known super-regenerative type, embodying an auxiliary oscillator which provides an unusually high degree of sensitivity without the inherent spilling over of the ordinary regenerative detector circuit.

The schematic diagram, Figure 100, illustrates the method of wiring the various components making up the receiver. Most of the parts are standard. The only parts not available on the market and which must be made are the grid and plate coils (L1, L2) for the detector, the radio-frequency transformer (L3-L4) of the auxiliary oscillator (see Figure 101) and a high-frequency choke (L5) for the detector plate. This choke may be made by winding 25 to 30 turns of number 36 wire on a piece of ¼-inch-diameter bakelite or hard rubber rod. The spacing between turns should be such that the winding is about 3 inches long. The grid and plate coils of the detector may be wound with round bus bar, using a large-diameter pencil for a form. Six or seven turns for each coil is generally satisfactory. The spacing between turns, which must be fairly large, has a great deal to do with the frequency range covered, so that the actual readjustments of these coils to the 5-meter band can best be made after the set is ready for a tryout.

Parts List

C1—Aerovox type 1450 fixed condenser, .002 mfd.
C2, C3, C5—Aerovox type 260 by-pass condensers, 1 mfd.
C4—Aerovox type 1460 fixed condenser, .005 mfd.
C6—Aerovox type 1450 fixed condenser, .001 mfd.
C7—Hammarlund type MC-20-S, 3-plate midget condenser
C8—Hammarlund type MC-140-M, 10-plate midget condenser
C9—Hammarlund type MICS-140, adjustable padding condenser, 70-140 mmfd.
J—Single-circuit (open) phone jack
L1, L2, L3, L4, L5—See text for constructional data
R1, R2—Resistors, 2000 ohms
R3—Resistor, 3 megohms
R4—Electrad type R1-205 potentiometer
R5—Resistor, 200,000 ohms
T—Audio transformer, ratio 1-3 or higher
3 Hammarlund Isolantite sockets, 5 prongs
12-inch length ¼-inch-diameter bakelite rod
2 Hammarlund flexible, insulated shaft couplings
1 grid clip
Miscellaneous bakelite pieces for shelves and bushings for mounting C7, C8 and oscillator coils L3-L4
2 type –37 tubes
1 type –38 tube
Aluminum for chassis and panel 1/16-inch stock, with 12½-inch right-angle brackets for assembling
1 5-wire battery cable
1 vernier dial

ACCURATE 5-METER MEASUREMENTS

Since the first strict enforcement of the 200-meter limitation, the problem of the amateur has been the dual one of designing transmission and receiving equipment effective within the allocations assigned him, and the perfection of measuring instruments which would enable him to tune accurately within legal bands. Off-frequency transmitters have been the initial characteristic of each successive drop in wavelength, the situation becoming more and

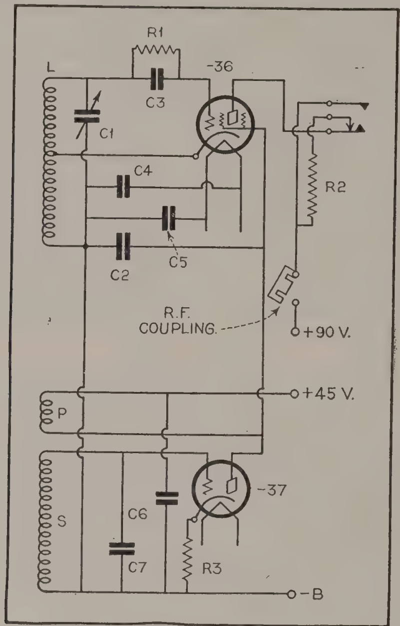


FIGURE 104

more erratic as new or lower wavelengths were opened up. Receivers were roughly calibrated against distant transmitters, presumably operating within lawful limits, to be used themselves as standards by other operators requesting QRH?". Hardly a precise system of wavelength determination but which, in the long run, with many stations using accurate wavemeters or checking their receivers against crystal-controlled standard frequency transmitters, resulted in a natural gravitation, throughout the country, toward the centers of the 80, 40 and 20-meter bands.

This system, however, will not work on the ultra-high frequencies, due to the limited range of such transmitters. It is a case of follow the leader, with no opportunity for double checking on distant stations. The net result is that while all 5-meter transmitters operating

within inter-communicating distances are tuned to approximately the same frequency, this frequency is not necessarily within the legal

FIGURE 105

limits and rarely if ever coincides with the "5-meter band" employed by distant groups of inter-communicating amateurs!

THE ULTRA-HIGH-FREQUENCY METER

While the direct spotting of a point in the 56 mc. band is a simple and practical method of eliminating the possibility of off-frequency operation, the more scientific procedure is to design and calibrate a special ultra-high-frequency meter, shown in Figure 105, against which standard the transmitter and receiver may be checked and calibrated in turn. A suitable circuit is shown in Figure 104.

Referring to Figure 104, coil L is wound with 2½ turns of number 14 wire on an R-39 form having a diameter of 1 inch. The tap is approximately one-third the way from the low-potential end. Coils P and S are respectively the primary and secondary of an audio-frequency transformer with the core removed.

Condenser C1 is the National ultra-short-wave type and has a capacity of 12 mmfd.; C2 and C3, .0001 mfd.; C4 and C5, .01 mfd.; C6, .1 mfd., and C7 varies from .01 to .1 mfd., depending on the constants of the transformer coils and modulation note desired.

R1 is a grid leak having a value of 5 megohms, while R2 has a d.c. resistance equal to that of the phones.

The potentials and tubes used are indicated on the diagram.

QUASI-OPTICAL WAVES

Relating to wavelengths of only a few centimeters, the laws valid for communication on the broadcast or even the short-wave channels down to 10 meters, are not valid any longer. These quasi-optical waves, as short as 18 centimeters, although purely electromagnetic waves, only of a tremendous higher frequency than the usual radio waves, are not reflected from the Heaviside layer like the so-called short-waves and therefore have not been used between points so far distant that the curvature of the earth would interfere with transmission. If larger than about three meters, electromagnetic waves will bend around obstacles, such as mountains or buildings or pass through them. These slightly longer waves are reflected from the Heaviside layer, remaining on the earth. In the dimension of the

ultra-short waves, however, a fair sized building is an obstacle sufficient to prevent the rays from penetrating through it. This is likewise true of hills and even of large trees.

Thus communication has only been tried between points on a straight line connection. These ultra-short waves travel like light; they are different from light, however, inasmuch as they are not absorbed by the dust, moisture and CO_2 content of the atmosphere, also that they are not acted upon by the heat-vibrations of the air, which are a heavy obstacle for long-distance communication along a path of modulated light in the ultra-violet, visible or infra-red region. These ultra-short waves travel like light, but have the agreeable distinction from light in not being influenced by the atmospheric condi-

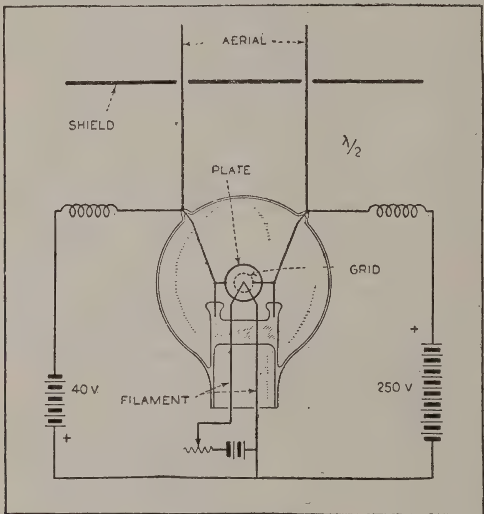


FIGURE 106

tions of rain, fog, day and night. Therefore, receivers and transmitters can be built which resemble the huge searchlights for visible light.

By bringing these ultra-short waves into the focus point of a reflector, they can be concentrated to almost a single line. Of course, there have been other methods for producing a directional effect for the longer waves. This has been accomplished by cutting out side radiation by interference and a partial loss of energy. For real reflection, the dimension of the wavelength has to be short in comparison to the dimension of the reflector. The size of the reflector is limited by practical size considerations. Thus reflection is to be expected only from those wavelengths which are small in comparison to the size of the reflector. In our particular case the wavelength, with which communication across the English Channel was main-

tained, is only about 7 inches. This is small enough to be handled properly by a reflector about 10 feet in diameter.

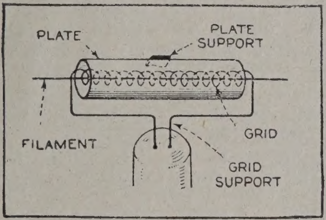
Work along the lines of ultra-short wave communication has been done independently in France and in Germany. All these developments go back to the fundamental investigations of Heinrich Hertz and the work of Barkhausen and Kurz.

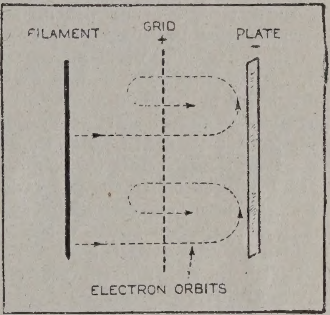
The illustration in Figure 106 shows the physical characteristics of the unique tube as used in the actual communication work in recent 18-centimeter tests of the International Telephone & Telegraph Co. across the English Channel. It has an output of .5 watt power.

As shown in the drawing the grid is not supported except at the terminals, as every connection between the windings of the grid would mean a partial short-circuiting of the grid. Special care has been

FIGURE 107—BELOW.

FIGURE 108—RIGHT.





taken in the design to choose the different parts of the lead-in wires and supports in a way so that they represent just fractions of one wavelength; the special wavelength for which the tube has been designed. Between the lead-in wires a shield of copper is attached to

protect the lower parts of the tube from the influence of the electric oscillations. The entire shield has a size of only 2.5 inches by 2.5 inches.

The distance between the actual oscillator (the space between grid and plate) and the shielding is exactly one-half wavelength. The other parts of the tube, the plate, the grid and the filament, have also been designed to represent exact fractions (or harmonics) of the wavelength. This is also extremely important for the distance *between* the lead-in wires. Special care has been taken to build the tube absolutely symmetrical.

In the oscillator, the grid is charged to a potential, say between 250 and 300 volts positive. The plate, however, has not only a lower potential than the grid but is kept even lower than the filament (about 40 volts negative).

In a transmitter or oscillator tube like this the oscillators, as Kurz and Barkhausen have shown, are not controlled by a direct coupling between the exterior circuits of the grid and the plate (not as in the audion, for instance). These oscillations or frequencies in the order of 1,600,000,000 to 6,000,000,000 cycles per second are created and generated by periodical movements of electrons within the space between grid and plate in such a way that they impress a harmonic of their frequency upon the oscillating circuit. See Figures 107 and 108. The wavelength itself is determined by the electrode-size and the voltages applied, a higher voltage being used for shorter wavelengths. A special tuning system has proven unnecessary. The electrode size and also the distances between the lead-in wires determine, to a very marked extent, the characteristic wavelength at which the tube will radiate.